



*THE HASHIMITE KINGDOM OF JORDAN
MINISTRY OF WATER AND IRRIGATION
WATER AUTHORITY OF JORDAN*

*NORTHERN GOVERNORATES WATER TRANSMISSION
SYSTEM*

EASTERN PRIMARY WATER TRANSMISSION PROJECT

*ZATARY PUMP STATION AND ZATARY HOFA
PIPELINE*

WAJ CONTRACT NO. _____/2006

***TENDER DOCUMENTS, VOLUME 2 OF 3
TECHNICAL SPECIFICATIONS***

PART I-DIVISIONS 1 TO 8

*FUNDED BY: UNITED STATES AGENCY FOR INTERNATIONAL
DEVELOPMENT (USAID), UNDER GRANT NO. 278-0288*

*CDM INTERNATIONAL INC.
AMMAN, JORDAN*

*May 2006
CDMPROJECT: 3029-42324*

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MINISTRY OF WATER AND IRRIGATION
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WAJ Contract No. _____/2006

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TENDER DOCUMENTS - VOLUME 2 OF 3

TECHNICAL SPECIFICATIONS

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SECTION 01010

SCOPE OF WORK - General

PART 1: GENERAL

1.01 BACKGROUND

The Water Authority of Jordan (WAJ) is an organization responsible to the Ministry of Water and Irrigation of the Hashemite Kingdom of Jordan for the implementation of the Northern Governorates Eastern Primary Transmission System Project.

The consulting engineer for this work is CDM International (CDM) in association with Consolidated Consultants (CC). The technical services for this project are funded by the United States Agency for International Development (USAID).

This project focuses on a critical system components of municipal water supply facilities needed within the service area of the Northern Governorates Water Authority (NGWA). That is the Eastern Primary Transmission System. This component forms the “backbone” of the NGWA eastern system, and expansions are needed in order to keep up with the expected increase in demand and this project is in phase with new projects that are anticipated to come online subsequently. The project comprises two components: Zatory pump station and a 48 km pipeline extending west from Zatory pump station to Hofa reservoir. The project area covers the Governorates of Mafraq, Jerash and Irbid. The Eastern Primary Water Transmission System Project consists of the supply, delivery, construction and pre-commissioning of a new pump station at Zatory and a new pipeline extending from the new Zatory pump station to the existing reservoir at Hofa.

1.02 THIS CONTRACT

This contract, pipeline and pump station, consists of the following specific components of the project:

- Construction of a new pump station at Zatory in Mafraq Governorate, including installation of pump station equipment;
- Construction of a control building at Zatory pump station, including installation of control equipment;
- Installation of the new Zatory pump station yard piping comprising a steel 1200 mm pump suction header and 1000 mm discharge header;
- Civil and landscaping works at the Zatory pump station site;
- Approximately 47,800 m of Ductile Iron Pipe pipeline ranging in size from 100 mm to 1000mm diameter with air release valves, gate valves, butterfly valves, wash outs; and,
- GPRS based telemetry system between the Zatory pump station and Hofa reservoir including intermediate control points.

1.03 WORK TO BE DONE

This contract will provide the **Zatary pump station and a 48 km pipeline extending west from Zatary pump station to Hofa reservoir**. Equipment, pipelines, and pump station and all other work will be constructed as shown on the drawings and in accordance with the specifications.

The Contractor is required to work closely with the residents and governmental entities (WAJ, et al) in the project area. The Contractor shall schedule his work to minimize the inconveniences to residents and all other entities. The Contractor shall provide safe access to entity facilities and residential dwellings and minimize dust and noise as much as practical. The Contractor shall be required to provide the necessary protection for the preservation of public and private property.

Maintaining traffic flow and pedestrian access, reducing utility interruptions to an absolute minimum, and solving utility conflicts are some of the activities which should be expected in the construction of this project.

This contract may interface with other projects being performed by Employer's own forces or other contractors in the Project area. In addition, water projects being performed by Employer's own forces or other contractors may be constructed simultaneously within the project area. The Contractor shall afford such other contractors proper and safe access to the site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other Work and shall properly connect, as required in the Contract, and coordinate the Works with such other contractors. Contractor shall do all cutting, fitting and patching of the Works that may be required to make its several parts come together properly and integrate such other Work that interfaces with its Works. Contractor shall not endanger any Work of others by cutting, excavating or otherwise altering their Work and will only cut or alter their Work with the written consent of the Employer, Engineer and the others whose Work may be affected.

The Contractor shall coordinate and cooperate with other contractors at all interface locations and other contractors performing Work in the Project area.

The duties and responsibilities of Contractor contained in the preceding paragraphs are for the benefit of such other contractors to the extent that there are comparable provisions for the benefit of Contractor in contracts between Employer and other contractors.

1.04 MONTHLY PROGRESS REPORTS AND MEETINGS

The Contractor shall submit a monthly progress report to the Engineer by the seventh day of each month during the entire duration of the Contract. The monthly progress report shall contain as a minimum the following:

1. Work completed for the previous month;
2. Work projected for the upcoming month;
3. Outstanding issues affecting the progress of the works;
4. Updated schedule as specified in Section 01300 Subsection 1.08-F;
5. Updated payment schedule;
6. Staff, equipment, and materials on site; and,
7. Results of any laboratory testing conducted by the Contractor for the previous month.

The format and quality of the first monthly progress report shall be reviewed by the Engineer. The Contractor shall make all subsequent monthly progress reports to the format and quality as indicated by the Engineer on the first report.

The Project Manager for the Contractor shall attend monthly progress meetings at the day, time, and location as designated by the Engineer. If deemed necessary by the Engineer, progress meetings may be conducted at any other time as designated by the Engineer in order to ensure the progress of the works.

1.07 REFERENCES

- A. Abbreviations and Symbols. The following abbreviations as referenced in the Contract Documents are defined to mean the associated names. Both the names and addresses are subject to change, and are believed to be, but are not assured to be, accurate and up-to-date as of the date of the Contract Documents.

AAMA	-	Architectural Aluminum Manufacturer's Association 35 East Wacker Drive Chicago, Illinois Drive 312/782-8256
AASHTO	-	American Assoc. of State Highway & Transportation Officials 444 North Capitol Street N.W. Washington, D.C. 20001 202/624-5800
ACI	-	American Concrete Institute Box 19150 Redford Station Detroit, Michigan 48219 31/532-2600
AFBMA	-	Anti-Friction Bearing Manufacturer's Association 1101 Connecticut Ave N.W. Washington, D.C. 20036 202/857-1100
AGA	-	American Gas Association 1515 Wilson Blvd Arlington, Virginia 22209 703/841-8400
AGMA	-	American Gear Manufacturer's Association 1500 King Street, Suite 201 Arlington, Virginia 22314 703/684-0211

- AISC - American Institute of Steel Construction, Inc.
One East Wacker Drive
Chicago, Illinois 60601
312/670-2400
- AISI - American Iron and Steel Institute
1000 16th Street, N.W.
Washington, D.C. 20036
202/452-7100
- ANSI - American National Standards Institute
(Successor to USAI AND ASA)
1430 Broadway
New York, New York 10018
212/868-1220
- APA - American Plywood Association
P.O. Box 11700
Tacoma, Washington 98411
206/565-6600
- API - American Petroleum Institute
2101 L. Street N.W.
Washington D.C. 20005
202/682-8000
- ASCE - American Society of Civil Engineers
345 East 47th Street
New York, New York 10017
212/705-7010
- ASHRAE - American Society of Heating, Refrigerating and Air
Conditioning Engineers.
1791 Tullie Circle, N.E.
Atlanta, Georgia 30329
404/636-8400
- ASME - American Society of Mechanical Engineers
345 East 47th Street
New York, New York 10017
212/705-7722
- ASTM - American Society for Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103
215/299-5400

- AWPA - American Wood Preservers Association
P.O. Box 849
Bethesda, Maryland 20014
301/642-7090
- AWWA - American Water Works Association, Inc.
2501 West Quincy Avenue
Denver, Colorado 80235
303/794-7711
- BSI - British Standards Institution
2 Park Street
London, W1A 2BS
01-629-9000
- CISPI - Cast Iron Soil Pipe Institute
1499 Chain Bridge Road
McLean, Virginia 22101
312/490-2000
- DHI - Door and Hardware Institute
7711 Old Springhouse Road
McLean, Virginia 22102
703/556-3900
- DIPRA- Ductile Iron Pipe Research Association
254 Riverchase Parkway East, Suite 0
Birmingham, Alabama
205/988-9870
- FGMA - Flat Glass Marketing Association
White Lakes Professional Building
3310 Harrison
Topeka, Kansas 66611
913/226-7700
- HI - The Hydraulic Institute
712 Lakewood Center N.
14600 Detroit Avenue
Cleveland, Ohio 44107
216/226-7700
- IEEE - Institute of Electrical and Electronic Engineers
345 East 47th Street
New York, New York 10017
212/705-7900

- IFI - Industrial Fasteners Institute
1717 East Ninth Street
Cleveland, Ohio 44114
216/241-1482
- ISO - International Organization for Standardization
1 Rue de Bernmba, Case Postale 56
Geneva 20, Switzerland
- NEMA - National Electrical Manufacturer's Association
2101 'L' Street, N.W.
Washington, DC 20036
202/797-5800
- NWMA - National Woodwork Manufacturer's Association
2-A Loudoun Street
Leesburg, Virginia 60606
312/782-6232
- OSHA - Occupational Safety and Health Administration
(U.S. Department of Labor)
Francis Perkins Bldg.
200 Constitutional Avenue, NW
Washington, D.C. 20202
- PCI - Prestressed Concrete Institute
201 North Wells Street
Chicago, Illinois 60606
312/346-4071
- SSPC - Steel Structure Painting Council
4400 Fifth Avenue
Pittsburgh, Pennsylvania 15213
412/621-1100
- TCA - Tile Council of America Inc.
P.O.Box 326
Princeton, New Jersey 8540
609/921-7050
- UL - Underwriters Laboratories Inc.
333 Plingisten Road
Northbrook, Illinois 60602
312/272-8800

B. Where reference is made in the Contract Documents to one of the above organizations

or other associations, comply with the standard which is in effect at the date of the Contract Documents.

- C. The use of alternative equivalent standards may be substituted upon the written request of the Contractor following award of the Contract. It is necessary to demonstrate to Engineer's satisfaction the suitability and equivalence of the substituted codes and standards. Should a conflict or a contradiction between the technical specifications, as contained in the Tender Documents, exist, then the more stringent and/or affording better quality material, product, equipment or workmanship, and those more beneficial to the Employer, shall prevail and be applied, as determined by the Engineer.
- D. The following abbreviations as referenced in the Contract Documents are defined to mean the following:

ac	-	Alternating current
AWG	-	American Wire Gauge
CIF	-	Cost, Insurance and Freight
cu	-	Cubic
dia	-	Diameter
F.L.	-	Flowline
g	-	Gram
ga, GA	-	Gauge
g/cm ³	-	Grams per cubic centimeter
ha	-	Hectare
IPS	-	Iron pipe size
kg	-	Kilogram
kg/cm ²	-	Kilogram per square centimeter
kg/cm ³	-	Kilogram per cubic centimeter
kJ	-	Kilojoule
Kn	-	Kilonewton
Kn/m ²	-	Kilonewton per square meter
kpa	-	kilo pascal
l	-	Litre or liter
l/m	-	Litres per minute
l/s	-	Litres per second
m	-	Meter
m ²	-	Square meter
m ³	-	Cubic meter
mm ²	-	Square millimeter
mN	-	Meganewton
mpa	-	Megapascals
max	-	Maximum
min	-	Minute or Minimum
mg/l	-	Milligrams per litre
Ml/d	-	Megaliters per day
NPT	-	National Pipe Thread
N	-	Newton
No.	-	Number

RL	-	Reduced Level
req'd	-	Required
rpm	-	Revolutions per minute
SWL	-	Static Water Level
typ	-	Typical
VA	-	Volt Ampere
IL	-	Invert Level
GL	-	Ground Level
NG	-	Natural Ground
ASPH	-	Asphalt
SC	-	Seal Coat

END OF SECTION

SECTION 01025

MEASUREMENT AND PAYMENT

PART 1: GENERAL

1.01 METHODOLOGY

- A. The Conditions of Contract, in particular Clauses 55 through 57 and 60 through 62 apply to this Section. Measurements are to be made to determine quantities of Work done, and payments shall be full compensation for such Work, as herein specified.
- B. Items of Work as shown in the Bills of Quantities (BOQ) will be paid for on the basis of measurements acceptable to the Engineer at the unit or lump sum price tendered.
- C. Partial payment will only be made for imported construction materials in transit or delivered and suitably stored as provided for in The Appendix to Form of Tender, after passing the specified tests. No other measurement for payment will be made on the basis of shipping weights or volumes nor for other materials delivered to the site but not installed in the completed Work.
- D. Payments will be made to the Contractor on the basis of estimates of the amount of Work completed at the time of the estimate and the value thereof as prepared by the Contractor, and as acceptable to the Engineer. However, measurement for payment does not signify that the measured works are accepted.
- E. Submit to the Engineer, within sixty (60) days after Notice to Proceed, a schedule of values. This schedule of values shall consist of a cost breakdown of an itemized listing of all lump sum and unit prices in the Contract. Where applicable, the schedule shall include estimated quantities and unit costs. This breakdown shall be as acceptable to the Engineer and will become the basis for determining progress payments for the applicable items and for negotiation of variation orders, if required.
- F. For the purpose of this Contract, maintenance, as required by the Tender Documents, shall be taken to mean repair and/or replacement of defective materials/workmanship.
- G. All longitudinal measurements of length, area or volume will be made horizontally along the center line of the Work, except as expressly specified otherwise herein.
- H. When a complete structural unit is specified as the unit of measurement (lump sum item), the unit shall be understood to include the complete structure and all associated work.
- I. Payment to the Contractor will be made for lump sum items constructed in accordance with the Contract Documents. Where an increase in the quantities is directed by the Engineer to construct a structure for which a lump sum has been tendered, payment for the additional quantities will be based on applicable acceptable unit prices submitted by the Contractor in his schedule of values of the Contract prices or an agreed upon lump sum for the extra work.
- J. Payments to the Contractor for unit price items will be made for the actual quantities of work items performed in accordance with the Contract Documents. If, upon completion of the construction, these actual quantities show either an increase or decrease from the

quantities stipulated in the BOQ, the Contract unit prices shall still prevail, subject to provisions of [Clause 52](#) of the Conditions of Contract.

- K. The aggregate final total quantity, as measured for payment for any specific tender item where the unit quantity is in meters will be to the nearest 10 centimeters.

1.02 MEASUREMENT AND PAYMENT

A. Included Works

The following are works which shall be deemed to be included in the unit rates of the relevant items. However, other works and materials which have not been specifically mentioned but could be reasonably implied or inferred from the drawings or the specifications, or are required for the proper execution and completion of the Works, shall be deemed included in the unit rates for the work item to which they relate:

1. Labor;
2. Materials;
3. Use of Plant;
4. All shop treatment of materials (e.g. preservation of timbers, galvanizing, priming, chrome plating, stove enameling, anodizing and the like; pipe wrapping, coatings, etc.);
5. Fitting and fixing materials in position;
6. Connecting the work of the item to other works, including cutting and shaping, fitting and jointing, and corporation valves, etc.;
7. All fittings, connections, branches, couplings and joints, sleeves, plugs, caps, stoppers, ties, fasteners and tappings as necessary, push-on or mechanical screws, nuts, bolts, gaskets, seals, etc., as required, shall be deemed included with the item to which they are installed;
8. Square raking or curved cutting. Junctions between straight, raking and curved work are in all cases included with the work in which they occur;
9. Work in volumes, in areas and lengths of any size and at any location or height; no separate items being measured for isolated work or work in small quantities, short lengths, narrow widths, etc.;
10. All incidental and temporary works and materials;
11. Waste of material;
12. Provision of samples;
13. Earthworks, where required but not specifically mentioned or allowed for under any work item in the BOQ shall be deemed included. Earthworks, wherever needed,

shall be deemed inclusive of;

- a. Cutting original surface and excavation in any soil, including concrete of any type, rock and boulders, to any depth and at any location;
 - b. Protection of existing structures and facilities, including repair and/or removal and replacement of damaged structures and facilities as directed and to the satisfaction of the Engineer;
 - c. Shoring, sheeting and bracing, and driving and removal thereof, including what is left in place when directed;
 - d. Dewatering and drainage where needed;
 - e. Leveling and/or grading and compacting bottoms of excavations;
 - f. Removal and disposal of excess excavated materials;
 - g. Clearing and grubbing easements where not included in separate item in the BOQ;
 - h. Backfilling in layers of specified material, including compaction;
 - i. Reinstatement of surfaces to original condition; and,
 - j. Removal or relocation of underground structures, pipes and facilities as directed.
14. Replacement and restoration of any works removed or disturbed.
 15. Concrete work, where needed or required but not specifically mentioned or allowed for under any work item in the BOQ, shall be deemed included. Concrete works, wherever needed, shall be deemed inclusive of any formwork needed, reinforcement where required and other works and materials, in compliance with Division 3 requirements, as applicable.
 16. Cleaning up, flushing and disinfecting the works during installation/construction and final cleanup upon completion.
 17. Testing of works and materials in factory and/or in-place, as specified, and commissioning.
 18. Spare parts and special tools not covered by a separate item in the BOQ, but otherwise specified or required.
 19. Start-up, pre-commissioning, commissioning, testing, operating and maintenance of the facilities.
 20. Traffic Control, Barricading and Street Closure Permitting (Section 01515).
 21. Environmental mitigation measures as needed or required.
 22. Establishment charges, on-costs, overhead charges and profit.

Notwithstanding Specification requirements for materials and/or equipment to be supplied under one division and fixed or placed in position under another division in the BOQ, all such materials/equipment are priced as supplied and fixed in the division in which they have been measured unless clearly stated as "Fix Only" or "Supply Only" items.

B. Payment

1. The compensation, as herein provided, shall be full payment for furnishing all materials, labor, tools, equipment and incidentals necessary for the completed Work and for performing all work intended and included under the Contract; for mobilization, demobilization and clean-up; for all temporary facilities and work; for all losses or damages arising from the nature of the Work or from the action of the elements and/or from any unforeseen difficulties which may be encountered during the prosecution of the Work, except for conditions as provided herein, until its final acceptance by the Employer.
2. Apart from imported construction materials, payment will be made for materials only when installed in place after passing all specified tests, as part of the item to which they relate, and no proportional payment shall be made for materials on the site but not yet installed.

1.03 EXCAVATION AND EARTHWORKS

A. Measurement

1. Measurement of the quantities of excavation and filling shall be measured net from the reduced or existing levels and/or contours shown on the drawings on the basis that the gradient of the existing surfaces between the nearest adjacent spot levels and/or between contours is constant. Ground level means any level of commencement of excavation.
2. Measurement of clearing and grubbing shall be the removal of top soil over the site area, inclusive of vegetation and roots, rocks, debris, etc. for the specified depth, and disposal of the resultant soil as specified and directed. Measurement will be in square meters.
3. Measurement of excavation for site grading over areas of buildings, pavements and roads, process areas, etc., and for foundations, shall be to the levels and grades specified and shown on the drawings, to depths and levels determined as herein below. Measurement shall be inclusive of stock piling and hauling satisfactory materials at approved locations (for reuse in backfilling) and disposal of unsatisfactory materials as specified or directed. Measurement will be in cubic meters.
4. Measurement of excavation depth shall be the difference between cleared (grubbed) top soil elevation and;
 - a. Subgrade level for roads and pavements;
 - b. Finished grade level over and around buildings and open areas;
 - c. Rough grading contours over and around process areas; and,
 - d. Bottom or/and top formation levels of foundations or blinding concrete for

buildings.

5. Measurement of backfilling shall be for finishing site grading over areas of buildings, roads and pavements, process areas, etc., using satisfactory excavated materials. Measurement shall include filling and compaction, forming and trimming slopes, and preparation of subgrade, all as specified.
6. Measurement for providing and laying a layer of agricultural soil shall be in square meters for the specified layer depth.
7. Included Works;
 - a. Additional excavation or filling required due to variation of the existing surface differing from a constant gradient between spot levels and/or between contours;
 - b. Hand or machine work or any combination of the two as may be found expedient;
 - c. for carrying out excavations in stages where required;
 - d. for segregation of excavated materials as required;
 - e. for grubbing up roots and root matter;
 - f. Getting out excavated material, shoring or planking and strutting;
 - g. Removing surplus excavated materials to temporary spoil heaps, creating spoil heaps and moving as required during the progress of the Works; and,
 - h. Additional excavation and/or filling required for working spaces around walls and footings beyond the external lines of said wall or external lines of blinding concrete.

B. Payment

1. Payment for site clearance shall be made for clearing and grubbing the site as determined above at the unit prices bid in the BOQ. The price and payment shall be inclusive notwithstanding the method, equipment and tools used, inclusive of disposal.
2. Payment for site grading shall be made for excavations over the site for buildings, pavements and roads, process areas, etc., as well as for foundations, shall be as determined above at the unit prices bid in the BOQ. The price and payment shall be inclusive of stock piling satisfactory materials and disposal of unsatisfactory materials as specified or directed, notwithstanding the method, equipment and tools used.
3. Payment for excavation and earthworks, generally, shall include for:
 - a. Planking and strutting to uphold the sides of excavation by any means necessary;
 - b. Excavation in any ground including rock, concrete or asphalt to any depth, which shall be removed with drilling equipment, compressors or rippers as approved;
 - c. Sorting excavated material;
 - d. Importation of additional material if insufficient is available on site and subsequent additional disposal;
 - e. Trimming, leveling and ramming bottoms of excavation;

- f. Double and multiple handling;
 - g. Stockpiling;
 - h. Keeping excavations free from storm water, percolating water and sub-soil water by pumping or any other means;
 - i. Finishing and grading to any falls, crossfalls or slopes that may be required;
 - j. Benchmarks;
 - k. Backfilling and consolidating/compacting selected excavated materials and imported granular filling in layers;
 - l. Temporary spoil heaps, provision of any approved tip and payment of all charges in connection therewith; and,
 - m. Warning markers.
4. Payment for providing and laying a layer of agricultural soil shall be inclusive of all costs, overheads and profit for selecting, hauling, transporting, preparation of layer location, laying, leveling and preparation to receive plants clean up and reinstatement.

1.04 CONCRETE WORK

A. Measurement

1. Generally

Concrete shall be measured net as placed and no deduction is made for voids not exceeding 0.10 m² in square area, voids not exceeding 0.05 m³ in cubic areas, or for the volume of any steel embedded in the concrete.

2. Concrete

- a. Blinding beds shall be measured in square meters stating the thickness.
- b. Slabs on grade and suspended slabs, shall be measured in cubic meters, and measurements shall be taken over all bearings.
- c. Foundations, wall footings and beams shall be measured in cubic meters as only that portion below the slab to which they are attached.
- d. Walls shall be measured in cubic meters notwithstanding their thickness.
- e. Columns shall be measured in cubic meters, from top of slab to underside of beams or slabs above.
- f. Electrical trenches in the electrical room shall be measured in meter run

3. Reinforcement

- a. Reinforcement, bar and fabric, shall not be measured as a separate item but will be deemed fully included with concrete.

4. Formwork

- a. Formwork shall not be measured as a separate item and shall be deemed fully included with concrete.

5. Precast Concrete Units

- a. Lintels shall not be measured as a separate item and shall be deemed fully included with the item in which they are embedded or fixed.
- b. Barrier curbs and edge/flush curbs shall be measured in linear meters.
- c. Precast concrete stepping tiles shall be measured by number.

6. Vapor and moisture barriers for all concrete surfaces in touch with soil or backfilled material other than bottom of horizontal concrete surfaces shall be measured in square meter. Vapor and moisture barriers for bottom of horizontal concrete surfaces shall not be measured and shall be considered as included work.

- a. All water, vapor and moisture protection works shall not be measured as separate items but shall be deemed fully included with the items to which they are applied or fixed.

B. Payment

1. Concrete

Payment for concrete work shall include for:

- a. Designing mixes, including any specified additives;
- b. Construction and control joints;
- c. Waterstops where installed;
- d. Laying in bays including temporary supports;
- e. Vibrating and packing around and between formwork;
- f. Curing and sprinkling;
- g. Work of any cross-sectional area and at any height;
- h. Cutting or forming grooves, throats, holes, chases, rebates, chamfers, splayed angles, molding and the like;
- i. Cutting or forming mortices and grouting in;
- j. Making good holes left by other trades;
- k. Grading, tamping and troweling surfaces of unset concrete;
- l. Hacking or otherwise treating surfaces of concrete to receive finish;
- m. Support reinforcement bars not indicated on drawings and as required;
- n. All bar and fabric reinforcement, installed complete in place;
- o. All formwork, notwithstanding its location, shape, size or surface finish it is expected to provide, including surface treatment to forms as specified;
- p. All surface finishes, including fair faced concrete and smooth surfaces;
- q. All construction and expansion joints, inclusive of their treatment, fillers, any temporary works, additional tying materials and all necessary works and materials; and,
- r. All vapor, moisture and water proofing works and materials (other than for roofs), notwithstanding their location, depth or thickness, complete.

2. Precast Concrete

Rates for precast concrete shall include for:

- a. Designing mixes;
- b. Lifting steel;
- c. Molds and surface finishes;
- d. Steel reinforcement, dowels and anchors;
- e. Concrete or mortar mix at in-situ joints;
- f. Transporting, hoisting, bedding and pointing in cement mortar
- g. Temporary supports; and,
- h. Fair ends, stooled ends, returned ends, rounded ends, mitred angles, rebated angles, intersections and the like.

3. Moisture Protection

Rates for moisture protection shall include for:

- a. Laps;
- b. Turn up at abutments;
- c. Cutting and waste;
- d. Reinforcing to cracks, construction or control joints or the like; and,
- e. Primers.

1.05 MISCELLANEOUS CONCRETE

A. Measurement

1. Measurement for payment for concrete furnished and installed shall be the actual quantity placed, irrespective of depth or location.
2. Concrete placed for miscellaneous purposes, where approved by the Engineer, will be measured in the units indicated in the BOQ.
3. Steel reinforcement for miscellaneous purposes shall not be measured as separate item but shall be deemed fully included with the items in which they are included.
4. Thrust blocks/anchors, where required and directed, shall be measured, as miscellaneous purpose concrete, net as the actual quantity placed in position.

B. Payment

1. Payment for miscellaneous concrete will be made for the quantity as above-determined at the unit price bid in the BOQ, and shall be full compensation for furnishing and placing the concrete including formwork and other materials required, complete as shown on the Drawings and as specified herein.

Thrust blocks and anchors shall be paid for, as the actual quantity placed, at the unit price bid in the BOQ for miscellaneous concrete.

3. Payment for reinforcing steel for miscellaneous concrete will not be made separately but will be considered as included in the respective rate of the concrete works.

1.06 UNIT MASONRY

A Measurement

1. All masonry works shall be measured net, in square meters, with no deductions made for voids not exceeding 0.10 m² in the face of the walls. Fair faced work, if any, shall be deemed included.

Masonry shall be measured and paid for concrete masonry units in 100mm and 150 mm walls, 300mm and 400mm cavity walls.

2. Hollow concrete rib blocks shall be measured by number

B. Payment

1. Generally

Rates for masonry works shall include for:

- a. Rebates, returns, thickenings and the like;
 - b. Filling ends of hollow blocks or providing special solid closer blocks, jamb units and the like;
 - c. Constructing cavities, including ties;
 - d. Control joints;
 - e. Shaping, cutting or forming chases, grooves, angles and rough and fair cutting and the like;
 - f. Raking out joints and pointing, as specified;
 - g. Raking out joints and/or hacking face of walls as required for key;
 - h. Raking out joints for flashings, caulking and the like;
 - i. Bedding and/or pointing plates, frame surrounds, sills, lintels and the like;
 - j. Temporary supports around windows, door frames and the like;
 - k. Building in or cutting and pinning ends of lintels, woodwork, steel sections and the like;
 - l. Cutting or forming holes for pipes, tubes, bars, cables, conduits, ductwork and the like, and mortices, sinkings, weep holes and the like, including grouting;
 - m. Making good all walls and making good fair face;
 - n. Tying in abutting concrete walls and columns;
 - o. Lintels and stiffener beams, notwithstanding their size; and,
 - p. Individual ties, anchorages and inserts.
2. Rates and payment for hollow concrete rib blocks shall be based on number of blocks placed actually in the slabs and shall be inclusive of all costs, overheads and profit associated with manufacturing, transporting, placing in the form work and waste.

1.07 ROOFING

A. Measurement

Roofing works shall be measured net, as fixed, in square meters. No deduction shall be made for voids not exceeding 0.50m². Measurement and payment for roofing works shall be made under two items; Waterproofing, and; Lightweight Insulating Concrete.

B. Payment

1. Waterproofing

Rate for waterproofing shall include for:

- a. Cleaning down and preparing surfaces, including primers;
- b. Any width or area;
- c. Laying to slopes, falls or crossfalls;
- d. Fair and rounded edges, drips, arrises and angle fillets;
- e. Cutting to line, overlapping;
- f. Skirtings, upstands and the like shall include for all additional material required, turning into grooves and pointing, flashings and reglets where required;
- g. Working into outlets, channels, gullies and the like; and,
- h. Cutting, trimming, making holes and forming openings, eaves, verges, etc., including working around pipes and openings and making good.

2. Lightweight Insulating Concrete

Rate for lightweight insulating concrete shall include for:

- a. Cleaning down and preparing surfaces;
- b. Any width or area;
- c. Finishing top surfaces to slopes, falls or crossfalls;
- d. Working around outlets, gullies, pipes and the like;
- e. Any lean concrete corner fillets required or shown on drawings; and,
- f. Trowel smooth surface finish.

3. Flashings, Capings, Expansion Joint Covers, etc.

- a. Flashings, capings, expansion joint covers and the like, complete, shall not be measured as separate items but shall be deemed fully included with the works to which they are installed or fixed.
- b. Works shall include all laps, angles, returned ends and the like; soldered or welded joints and the like; additional material at all dressings and labor; cleats, reglets, anchors, supports, leveling shims, fixings and the like; pointing or caulking; and all mortars, grouts and other bedding or leveling materials.

1.08 INSULATION

A. Measurement

1. Extruded polystyrene boards insulation works shall be measured net as fixed, in square meters. No deduction shall be made for voids not exceeding 0.50 m².
2. No measurement shall be made of insulation for equipment, piping and the like, which

shall be deemed included with the work to which they are installed.

B. Payment

Rates for insulation shall include for:

1. Mechanical fasteners, adhesive tape and the like;
2. Holes, clips, wires, etc. for through fixing of metal supports for other work;
3. Working into outlets, channels, gullies and the like;
4. Cutting, trimming, making holes and forming openings, eaves, verges, etc., including working around pipes and openings and making good; and,
5. Making good to coverings, including replacement thereof.

1.09 METALWORK

A. Measurement

1. Metalworks in general are measured by the number.

B. Payment

1. General

Rates for metalwork shall generally include for:

- a. Cutting members to length;
- b. All scribing, rebates, grooves, chamfers, splayed and rounded edges, tongued angles, beads, moldings, fair and returned ends, miters, housing, holes for pipes, etc. and for all short or isolated lengths;
- c. For all shop and site welding;
- d. Grinding, drilling, countersinking, bolting and riveting;
- e. Assembling, adjusting and fixing complete; and,
- f. Cleaning and preparing surfaces to receive finishes including all treatments, primers and finishes.

2. Doors, Windows and Louvers

Rates for doors, windows and louvers shall include for:

- a. Members of any section as required;
- b. Welding, brazing or the like at corners, intersections or the like;
- c. Openings for lights;
- d. Cutouts for ironmongery and hardware, etc.;
- e. Metal frames;
- f. Flyscreens or washable filters and sand trays as required;
- g. Hardware sets complete, including screws and fixing accessories; temporary fixing and refixing; three keys to each lock, and the required number of master keys as specified; rags, keyboards, etc.;
- h. Work at jambs or heads including expanded metal lathing, fixing cramps, wall

- anchors, grounds, bedding, filling frames with grout, galvanized mild steel plaster guards, motor boxes, stops, beads and caulking sealant, as necessary;
- i. Reinforcement for hinges, hardware, etc.;
- j. Glazing;
- k. Glazing beads, strips, gaskets or other material as detailed;
- l. Weatherproofing;
- m. Cleaning and preparing surfaces to receive finishes including all treatments, primers and finishes; and,
- n. Roll-up doors shall be measured complete, including operating mechanism, top, cover and tracks.

3. Handrails, Guard Rails, Grabrails, Balustrades, Grilles, etc.

Rates for handrails, guard rails, grabrails, balustrades, grilles or the like shall include for:

- a. All angles, bends, ends, returns, etc.;
- b. Extra material for supports and building into structure; and,
- c. Cleaning and preparing surfaces to receive finishes including all treatments, primers and finishes.

4. Rails and Tracks for Cranes and Lifting Systems

Rails and tracks for monorails, overhead cranes and the like shall not be measured as separate items, but shall be included with the rates for the cranes and lifting systems to which they belong, and shall include for:

- a. All steel beams, elements and the like;
- b. All fixings including embedded fixations, anchors and the like in other works;
- c. All necessary civil and builder's work in connection with other trades;
- d. Cleaning and preparing surfaces to receive finishes including all treatments, primers and finishes; and,
- e. Accessories.

1.10 FLOOR, WALL AND CEILING FINISHES

A. Measurement

1. Finishes, in general, shall be measured in square meters, of the net quantity of finish works, complete as installed and as herein specified. No deduction shall be made for voids not exceeding 0.50 m².
2. All insitu wall finishes shall be measured to finished floor level except in the instance of a turn up base where the finish is taken to top of base.
3. All thicknesses shall be regarded as minimum or average as necessary.
4. Plastering shall be measured from top of finished floor level to underside of slab/beam above, whether a false ceiling is installed or not, except when a skirting is installed then the measurement commences from top of skirting.

5. Local marble for window, door and parapet sells, thresholds and coping shall be measured in meter run for each specified marble width and thickness

B. Payment

1. Insitu Finishes

Rates for insitu finishes shall include for:

- a. Application to and preparation of any surfaces, including guide screeds and the like;
- b. Wire mesh at junctions between differing materials and at construction joints;
- c. Any width or area, any location or height;
- d. Finish to surfaces, to falls, crossfalls and slopes, including making good after all trades;
- e. Working into channels, around gullies, outlets and the like;
- f. Fair joints, fair edges, rounded edges, chamfered edges, sharp arrises, rounded angles, cover angles and the like;
- g. Plaster corner beads at external angles and casing beads;
- h. Admixtures, pigments and sealers; and,
- i. Control joints.

2. Tile, Local Marble, Slab and Concrete Unit Paver Finishes

Rates for tile, slab and concrete unit paver finishes shall include for:

- a. Application to and preparation of any surface;
- b. Cleaning stone pavings prior to laying;
- c. Any width, pattern or area, any location;
- d. Grouting and pointing, including color pigments and additives;
- e. Finish to surfaces, to falls, crossfalls and slopes;
- f. Grinding, cleaning, polishing and waxing;
- g. Special sizes and shapes, as well as fair, rebated, rounded, chamfered, splayed, beveled and molded edges, grooves, flutes and the like;
- h. Square, raking and circular cutting and waste;
- i. Cutting and fitting into any opening or recessed area, and fitting around any section;
- j. Edge and dividing strips at such intervals that the paving is divided into specified bays, and at intersections between differing materials;
- k. All supports and fixation as specified and required; and,
- l. All mortar and other setting beds and additives, including the required sand/gravel layer to the required levels.

1.11 PAINTING

A. Measurement

All painting works for walls, floors and ceiling and where not specified as included with the item to which they are applied, shall be measured in square meters. No deduction shall be

made for voids not exceeding 0.50m².

B. Payment

1. Rates for painting shall include for:

- a. Preparation of paint and preparation of surfaces to be painted, including any required primers, sealers and the like;
- b. Any type of work in any area or width, in any location and at any height;
- c. Work in multi-colors;
- d. Cutting in edges and rubbing down between coats;
- e. Sealing all knots and end grain to timber sections;
- f. Making good after all trades; and,
- g. All masking work for paint application.

1.12 GLAZING

A. Measurement

All glazing, including mirrors, shall be deemed fully included with the relevant items into which they are to be incorporated, i.e. doors, screens, windows, toilet and bathroom accessories, etc..

B. Payment

No separate payment shall be made for glazing work, which shall be deemed to include for:

1. Any pattern, size and area;
2. Circular and square cutting with rounded edges;
3. Spacers, beads, strips, gaskets and other materials as required;
4. Glazing to wood or metal;
5. Mirror clips; and,
6. Bedding edges and labors to edges, including rounding edges of all panels to prevent damage to gaskets.

1.13 FITTINGS AND FURNISHINGS

A. Payment

1. Architectural Woodwork

The rates for architectural woodwork shall include for:

- a. Assembling and fixing;
- b. Scribing, notching, etc.;
- c. Special shapes, composite corner units and the like;
- d. Timber grounds, bearers and framing;
- e. Supports; and,
- f. Ironmongery
- g. Finishings and decoration, including application of preservative where

- h. Any required sealants at edges.

2. Metal Casework

The rates for metal casework shall include for:

- a. Timber grounds, bearers and framing
- b. All end and back panels, including supports to casement units
- c. Cutting to size all countertops
- d. Cutting out in countertops for sinks etc., including all additional framing
- e. Cutting out in panels for pipes etc., including all additional framing.

1.14 MOBILIZATION

A. Measurement

- 1. The Contract Bank Guarantees and/or Bonds, Insurance, Contractor's office, Engineer's office and the Miscellaneous Mobilization items shall be measured on lump sum basis.
- 2. Measurement of Engineers vehicles shall be by number.
- 3. Project signs shall be measured by number

B. Payment

- 2. Price and Payment for all Contract Bank Guarantees and/or Bonds shall cover all costs, overheads fees and profit associated with all bank guarantees specified in the Contract Documents. Other not specified guarantees and/or Bonds shall not be paid for separately and shall be considered included in other items.
- 3. Price and Payment for all Insurance shall cover all costs, overheads, fees and profit associated with all insurance specified in the Contract Documents. Other not specified insurance shall not be paid for separately and shall be considered included in other items.
- 4. Price and Payment for Miscellaneous Mobilization Items shall cover all costs of all works, overheads, fees and profit associated with all Miscellaneous Mobilization inserted in the BOQ by the contractor.
- 5. Price and Payment for Contractor's Office shall cover all costs of all works, overheads, fees and profit associated with establishing and starting up the contractor's office.
- 6. Price and Payment for Engineer's Office shall cover all capital and running costs of all works, overheads, fees and profit associated with establishing the Engineer's office including supply, install and maintain of all items specified in items 1.01 and 1.02 Section 01501 for the project duration. Partial payments for the Engineers office shall be made on the basis of the schedule of values estimates of the Engineers office capital upfront costs and the monthly running costs.
- 7. Price and Payment for Engineer's vehicles shall cover all capital costs , overheads, fees and

profit associated with providing the vehicles. Engineer's vehicles running costs for the project duration (fuel, maintenance, insurance etc...) shall not be measured and payed for separately, those will be part of the contractor's overheads.

8. Price and Payment for project signs shall cover all costs of all works, overheads, fees and profit associated with designing, submittals, manufacturing, painting, installing and maintaining the project signs

1.15 SPECIALTIES

A. Measurement

Measurement of Signage, Fire Extinguishers and Accessories and Toilet and Shower Accessories shall be by the number.

B. Payment

The rates for specialty works shall include for:

1. Section 01300 requirements (schedules)
2. preparation of design for Signage
3. Assembling and fixing
4. Special shapes, composite corner units and the like
5. Cutting to size, scribing, notching, etc. where required
6. Grounds, bearers and framing
7. Supporting systems and fixings
8. Cutting into works by other trades and making good existing works
9. Finishings and decoration, including application of surface treatments where necessary prior to decoration
10. Any required sealants and the like at edges.

1.16 EQUIPMENT

A. Measurement

Equipment shall be measured by the number, complete on a lump sum basis.

B. Payment

1. General: Rates for equipment shall include for:
 - a. Fixings
 - b. Timber grounds, bearers and framing
 - c. Water, waste, gas oil, electrical connections and control panels if required, including maintenance valves, disconnect switches and all other incidentals as specified or shown on drawings.
 - d. Operating and maintenance manuals in English
 - e. Identification plates, discs, labels and key charts in Arabic and English languages
 - f. Painting

- g. Cleaning
 - h. Testing
 - i. Spare parts as specified.
2. Rate of steel horizontal surge vessels 95m³ each shall include
 - a- Surge vessel to the dimensions as shown on the drawings
 - b- Foundation, anchors and supports
 - c- Excavation, selected fill material, base course and blinding concrete
 - d- Surge vessels connection to water inlet valve, drain valve, inspection manhole and cover, safety valve, air inlet isolating and non return valves and all air piping connections.
 - e- Galvanized steel ladder
 - f. Level control, site glass and isolating valves, magnetic and level switches, wiring and cabling.
 - g- All other items specified and/or required for the proper performance of level control system
 - h- Gaskets, bolts, nuts etc
3. Rate of Hydro-Pneumatic Surge Arrestor System shall include
 - a- Surge arrester system design and shop drawings
 - b-compressors and driving motor with auto loading and unloading devices, foundation and anchors, isolating non return valves and safety valves, cooling system, inlet fillers, separator, and fine filter all other items specified in Section 11373
 - c- Air Receiver(s) including air recover with inspection manhole, foundation support, air inlet, outlet, safety, non return, hand drain valves, auto drain, pressure gauge, isolating valve and pressure control devices
4. Rate for Vertical Turbine Canned Pump shall include
 - Pump and motor set
 - Monitor devices for bearings, winding temperature and vibration
 - Bolts, nuts and gaskets
 - Pressure gauge
 - All other items specified in Section 11214
5. Rate for Cans for Vertical Turbine Pumps shall include
 - can with vanes as shown on the drawings
 - supporting flange and bolt
 - suction branch and flange
 - air vent and its isolating valve
 - pressure pumps with isolating valve and tube
6. Rate for Steel covers for future VTC pumps shall include
 - steel cover 25 mm thick
 - gasket, bolts and washers
 - plugged connections for future air vent and pressure gauge
7. Rate for Control panel for compressor and surge vessel equipment shall include
 - steel enclosure IP54

 - hand/auto start/stop selector switch, reset, and alarm push bottom

- MCCB contactors, relay, timers, alarm buzzer, wiring, interlock wiring and cables
 - voltmeter, ammeters, indication lamps for healthy power supply running and stop
8. Rate for Pump Suction Line shall include
- pipe from pump can suction flange up to the exterior surface of pump building wall
 - connection to pump can
 - necessary bolts, nuts, gaskets
 - excavation, back fill pipe reinforced concrete encasement
9. Pump Discharge Line
- pipe spools from pump discharge flange up to the exterior surface of the pump building wall
 - pipe supports
 - eccentric reducer
 - restrained flexible joints
 - air vent, with isolating valve
 - pressure gauge with isolating valve
 - non return valve
 - gat valve
 - supports
 - sleeve
 - bolts nuts and gaskets
10. Rate for Future Pump Discharge Line shall include
- pipes
 - gate valve
 - blind flange
 - sleeve
 - bolts, nuts and gaskets
 - support
11. Rate for Air conditioning units shall include
- split units indoor and outdoor elements
 - sleeves through walls
 - wiring and cabling and controls
 - foundation
12. Rate for Exhaust Fans shall include
- fans
 - auto louvers
 - frame
 - wiring and connection
13. Rate for Safety Devices / Equipment shall include all those items specified in Section 11501
14. Rate for Maintenance and Miscellaneous Equipment shall include all items specified in Section 11510

1.17 OVERHEAD CRANE

A. Measurement

Measurement of overhead crane shall be by on the lump sum basis, inclusive of the metal beams and supports, and operating mechanisms.

B. Payment

Rates for crane and lifting installations shall include for:

1. Metal beams, rails and tracks
2. All fixations, anchors and the like
3. Identification plates, discs, labels and key charts in Arabic and English languages
4. Operating and maintenance manuals in English
5. Accessories
6. All necessary builder's work in connection with other trades
7. Painting
8. Cleaning
9. Testing.

1.18 PIPING

Measurement and payment for the piping works shall be divided into yard piping, transmission pipeline, , steel pipes for washouts and valves. These items include Ductile Iron (DI) pipe, steel pipes, valves and appurtenances.

A. Transmission Pipeline Works

1. Measurement

- a. Ductile iron pipe of the type, class and size specified in the Contract Documents, as provided for in the BOQ, will be measured actual in place on a linear meter basis for all DI pipeline (from station 0+000 up station 47+800). and branches
- b. Measurement of pipe works for length will be along the actual centerline of the pipe inclusive of all fittings (tees, bends, crosses, reducers, couplings, retainer rings, sleeves, tappings, restrained joints etc., including glands, bolts, nuts, tie rods, gaskets and other accessories) irrespective of their weight, but exclusive of valves which are measured separately. No deduction of pipe length shall be made for pipe within chambers. Measurement will be to the nearest ten (10) centimeters.

Spares required by the specifications and/or drawings but not allowed for as separate items in the BOQ shall be deemed included with the items/ works to

which they belong.

2. Payment

- a. Payment for furnishing and installing pipes will be made for the respective size, nominal pressure and quantity as determined above at the unit prices bid under the relevant Items in the BOQ. These prices and payments shall be inclusive of all works and materials as mentioned in 1.02 (A) above, as applicable, including excavation and earthworks; furnishing sand bedding and embedment, filling and backfilling as specified; furnishing, laying, jointing and connecting to other pipes, fittings, valves, etc., inclusive of furnishing and installing all fittings, joints, nipples (and sleeves and tees associated with those nipple pieces), connections and branches; lining, coating, packing and wrapping; cutting the pipe, if necessary; temporary plugging and capping; flushing, disinfecting, cleaning and testing the pipeline during construction and upon completion; and all incidental work and materials, and all else incidental thereto, for which separate payment is not provided under other items in the BOQ.
- b. Partial payment requests for ductile iron pipes and fittings properly tested and delivered to the Site but not installed shall be eligible for payment in accordance with the Appendix to Form of Tender, Volume I of the Contract Documents.
- d. Notwithstanding acceptance and/or measurement, a percentage of the payment due for furnishing and installing pipeline may be retained on the partial payment requests until the pipeline is tested as specified herein.

B. VALVES AND APPURTENANCES

1. Measurement

- a. Valves and appurtenances of the type and size specified in the Contract Documents, buried, in manholes, in surface boxes or underground vaults, as provided for in the BOQ, will be enumerated as actually installed and accepted by the Engineer.
- b. Valves shall be measured as complete units of the following types:
 - Butterfly Valves
 - Gate Valves
 - Air Release Valves
 - Combination Valves
 - Wash Outs
 - Refurbishment of Existing Combination Valves

2. Payment

- a. Payment for furnishing and installing valves will be made for the quantity as determined above at the unit prices bid in the BOQ. This price and payment shall be full compensation for setting and jointing, inclusive of all works and materials as

mentioned in 1.02 (A) above, as applicable, including furnishing and installing joints and fittings, puddle flanged pipe spools faucets, standpipes and extension shafts, operating nuts, valve boxes with adapters and covers;

operating keys and wrenches; fasteners, ring seals, bonnet, tie rods and gland bolts and nuts; wedges, tapping sleeves, armored end gaskets and flanges; converters, where required; wiring and controls, if applicable; position indicating devices; surface boxes and covers, including excavation, backfilling, reinforced concrete vaults complete, and blinding where required; precast concrete covers, extensions and leveling rings, manhole frames and covers, and

manhole rungs; gravel pack were indicated; ventilation pipes;; flushing, cleaning and testing the items during construction and upon completion; and all work required for or incidental to the satisfactory completion of the items for which separate payment is not provided under other items in the BOQ.

- b. Partial payment requests for valves and appurtenances properly tested and delivered to the Site but not installed shall be eligible for payment in accordance with the Appendix to Form of Tender, Volume I of the Contract Documents.
- c. Payment for valve units shall, in addition to (a) above, include and be divided into the following types;

- I. Butterfly Valves

- The reinforced concrete chamber complete as shown on the drawings and details; precast concrete manhole rings inclusive of cast iron frame and cover, and manhole rungs; butterfly valve; ventilation pipe complete with all its accessories, gaskets, bolts counter flanges, nuts, etc.; gravel pack; all fittings, gaskets, bolts, nuts and accessories as needed for a complete and operable installation.

- II. Gate Valves

- The reinforced concrete chamber complete as shown on the drawings and details; or reinforced concrete surface box complete; precast concrete manhole rings inclusive of cast iron frame and cover, and manhole rungs; gate valve; ventilation pipe complete with all its accessories, gaskets, bolts counter flanges, nuts, etc.; gravel pack; all fittings, gaskets, bolts, nuts and accessories as needed for a complete and operable installation.

- III. Air Release Valves

- The reinforced concrete vault complete as shown on the drawings and

details; precast concrete cover, manhole rings inclusive of cast iron frame and cover, and manhole rungs; air release valve, gate valve and shut-off valve; and ventilation pipe complete with all its accessories, gaskets, bolts, counter flanges, nuts, etc.; gravel pack; and all fittings and accessories as needed for a complete and operable installation.

IV. Combination Vacuum/Air Release Valves

The reinforced concrete structure complete as shown on the drawings and details, including valve seats; precast concrete manhole rings inclusive of cast iron frame and cover, and manhole rungs; fittings, gate valve, flexible joint, separate body air release valve and vacuum release valve and ventilation pipe complete.

V. Wash Outs

The reinforced concrete chamber complete as shown on the drawings and details, including valve seats; precast concrete manhole rings inclusive of cast iron frame and cover, and manhole rungs; isolation gate valve and dismantling piece, and wash-out valve; ventilation pipe complete with all its accessories, gaskets, bolts, counter flanges, nuts, etc.; and all fittings and accessories as needed for a complete and operable installation.

Payment for wash outs shall in addition include for reinforced concrete cut-off wall, required tee, as well as the construction of a stone rip-rap for drainage removal. Payment shall exclude the steel wash out pipe which shall be measured and paid for with the pipeline.

V. Refurbishment of Existing Combination Valves

Breaking and removing the upper 0.5 m of the existing vault walls, 0.7 m reinforced concrete walls and precast concrete cover complete as shown on the drawings and details, including valve seats; fittings, gate valve, separate body air release valve and vacuum release valve and ventilation pipe complete.

C. Yard Piping

1. Measurement

- a. Measurement for payment for yard piping shall be on a lump sum basis for Zatory pump station, inclusive of the following:
 - i. 1200 mm steel suction pipe and its 600 mm branches from the new suction sump up to the pump building wall external surface
 - ii. 400 mm steel discharge pipes and 1000 mm discharge header from the pump building walls external surface up to station 0+000 on the DI pipeline
 - iii. Surge Arrestor System's 700 mm, 400 mm, 50 mm, and 25 mm

water and air piping from the pump building wall external surface and from the discharge header up to the surge tanks

- iv 400 mm steel washout valve and pipe from the discharge header up to and inclusive of the connection to existing manhole.
- iv. All valves, fittings and appurtenances complete, including, Gate valves, Butterfly valves, check valves, wash-out and magnetic flow meters located within the yard piping specified herein above
- vi. All civil works, including tunneling under existing reservoir, trenching and backfilling, excavation, valve, and magnetic meter vaults, complete.

2. Payment

- a. Payment of the lump sum prices bid in the BOQ for yard piping shall be full compensation for all costs associated with the provision of materials and works for Zatory pump station, piping, valves and appurtenances, including manholes, vaults, boxes, etc., all as specified in the relevant sections herein above, and all other works and materials as required within the boundaries specified herein above. These prices and payments shall be inclusive of all works and materials as mentioned in 1.02 (A) above, as applicable, and all other works required for or incidental to the satisfactory completion of the items for which separate payment is not provided under other items in the BOQ.
- b. Partial payment requests for imported materials (pipes and valves and appurtenances), properly tested and delivered to the Site but not installed shall be eligible for payment in accordance with the Appendix to Form of Tender, Volume I of the Contract Documents.

D. Steel Pipes for Washouts

1. Measurement

- a. Steel pipe for washouts of the type, class and size specified in the Contract Documents, as provided for in the BOQ, will be measured actual in place on a linear meter basis. The steel pipe for washout located within the Zatory PS will not be measured and paid for under this item as it is included in the Yard Piping item
- b. Measurement of pipe works for length will be along the actual centerline of the pipe from the flange connected to the washout gate valve up to the washout discharge point but exclusive of the valve which is measured separately. No deduction of pipe length shall be made for pipe within chambers. Measurement will be to the nearest ten (10) centimeters. The concrete cut of wall and riprap at the discharge of the washout pipe shall be considered included in the washout pipe measurement and shall not be measured separately

2. Payment

- a. Payment for furnishing and installing steel pipes for washouts will be made for the respective size, nominal pressure and quantity as determined above at the unit prices bid under the relevant Items in the BOQ. These prices and payments shall be inclusive of all works and materials as mentioned in 1.02 (A) above, as applicable, including excavation and earthworks; furnishing sand bedding and embedment, filling and backfilling as specified; reinforced concrete for cut off wall and riprap at the discharge side of the washout, furnishing, laying, jointing and welding, etc., inclusive of furnishing and installing all fittings, joints; lining, coating, packing and wrapping; cutting the pipe, if necessary; temporary plugging and capping; flushing, disinfecting, cleaning and testing the pipeline during construction and upon completion; and all incidental work and materials, and all else incidental thereto, for which separate payment is not provided under other items in the BOQ.

E. Spare Items

1. Measurement

- a. Measurement of the Ductile Iron spare pipes will be by meter run
- b. Measurement of the spare butterfly valves, dismantling joints and gate valves will be by the number

2. Payment

- a. The rates for all spare items: Ductile Iron spare pipes, butterfly valves, dismantling joints and gate valves shall include all costs associated with procurement shipping and delivery to the Employer's specified warehouse

1.19 PLUMBING, SEEPAGE PITS AND SEPTIC TANK

A. Measurement

1. Drain and sanitary sewer piping in all systems shall be measured in linear meters, taken along the actual center line over all fittings.
2. Manholes, or the like measured by the number, complete on a lump sum basis including manhole covers.
3. Septic tank shall be measured on lump sum basis
4. Seepage Pits shall be measured on by number basis
5. Galvanized steel pipes for potable water system shall be measured in linear meters, taken

along the actual center line over all fittings.

6. Potable water distribution boxes and PE piping shall be measured by the number on lump sum basis

B. Payment

1. Pipework for sanitary sewers and surface water drainage

Rates for pipework shall include for:

- a. Assembly, fitting and jointing together of components
- b. All joints and couplers in the running length
- c. Adaptors for jointing together pipes and fittings of different materials
- d. All fittings in the running length e. Testing the systems
- f. Marking tape for sewers out side building.

2. Manholes

Manholes or the like shall include for:

- a. All formwork and reinforcement
- b. All precast elements
- c. Benchings
- d. Galvanized steel step irons
- e. Forming holes and making good for pipes
- f. Testing.
- g. Cast iron manhole covers

3. Septic Tank

This price and payment for the septic tank shall be full compensation, inclusive of all works and materials as mentioned in 1.02 (A) above, as applicable, including excavation, backfilling, blinding, reinforced concrete for all structures septic tank and perculating structure shown on the Septic Tank drawing, granular fill material, manhole covers galvanized steps etc.

4. Seepage Pits

The rate and payment for seepage pits shall be full compensation, inclusive of all works and materials as mentioned in 1.02 (A) above, as applicable, including excavation, backfilling, lean concrete, block walls and gravel fill material.

5. The rate for the potable galvanized water pipes shall be full compensation for all works including, fittings, valves, coating with primer and wrapping with PE tape for buried pipes, sleeves excavation and backfilling for pipes in trenches

6. The rate for water distribution boxes shall be full compensation for all relevant works including the steel cabinet, inlet valve, inlet header, outlet branch valves, polyethylene sleeves and piping, adapters and connection to accessories.

1.20 MECHANICAL INSTALLATION

A. Measurement

1. Pipes shall be measured as indicated in the BOQ
2. Ducting shall not be measured as a separate item but shall be deemed fully included with the installation, regardless of its weight inclusive of all thermal insulation, lining, fittings, hangers, supports and brackets, vapour barriers, adhesive, sealers, protective finishes and all cladding where required.
3. Sanitary Fixtures shall be measured by the number, inclusive of all accessories.
4. The following descriptions, within the building, only shall mean:
 - a. Trenches shall mean excavation, compaction, supports, disposal, sand bed or the like and selected earth filling as necessary.
 - b. Walls shall mean fixing either vertically or horizontally as required, to any surface.
 - c. Walls in ducts shall mean fixing either vertically or horizontally as required in confined spaces, to any surface.
 - d. Soffits shall mean fixing horizontally as required and shall include short length wires through slabs or the like.
 - e. Plant room or boiler room shall mean pipes that can either be supported from floor or ceiling or any other means at the Contractor's option and the Engineer's approval.
5. Fittings (e.g bends, tees, junctions, reducers, etc.) on pipes are included with the pipes.
6. Valves or the like have been measured separately, unless included with equipment.
7. Hose bibs and hose reel shall be measured by the number
8. Cleaning shall mean removing protective wrapping, cleaning where necessary as the work progresses and again on completion.
9. Identification shall mean the provision of plates, discs, labels and other schemes of the required parts of the installation including charts and the like.
10. Testing and commissioning shall mean to the satisfaction of the Engineer and to the satisfaction of any Committees that shall be appointed by the Employer.

B. Payment

1. General

Rates for installation generally shall include for:

- a. Identification plates, discs, labels and key charts in Arabic and English languages
- b. Testing and commissioning including the provision of instruments, appliances, fuel, water, lighting and attendance
- c. Operating and Maintenance manuals in English language
- d. Colour coding
- e. Marking out
- f. Assembly, fitting and jointing component parts
- g. Patterns, molds, templates and the like
- h. Cutting away and making good and all other necessary builder's work
- i. Painting
- j. Fixing including screws, bolts and the like
- k. Cleaning.

2. Pipes

Rates for pipes shall in addition include for:

- a. Joints and couplers in the running length
- b. Providing materials, heat welds and weld metals, bolts, nuts, gaskets, washers and everything else necessary for making joints in pipes
- c. Pipe supports, (e.g. clips, pipehooks, holderbats, hangers, rollers) sleeves and wall, floor or ceiling plates
- d. Shock absorber and all other means to prevent water hammer
- e. Drain off points, air ventilators and automatic air vents
- f. Capped ends for future connection
- g. All thermal insulation.

3. Equipment

Rates for equipment and plant shall include for:

- a. Anti-vibration insulation, insulators and backing insulation, anti-vibration mountings, flexible connections, flanged, welded and screwed connections
- b. Hangers, straps, brackets and the like
- c. Connections of water, sanitary, gas or electrical services
- d. Valves, gauges, thermometers, thermostats, control equipment and the like
- e. All thermal insulation
- f. All ducting, complete.

4. Sanitary Fixtures

Rates for sanitary fixtures shall in addition include for:

- a. Bedding and pointing with mastic sealant
- b. Isolators and valves for the services
- c. Short lengths of chromium plated tubes to nearest main run
- d. Traps
- e. Connections to water and sanitary services.

4. Hose Bibs

Rate for hose bibs shall include for connection to the supply line, galvanized pipes and fittings, isolating valves, concrete base and support for bib station, hose reel and protection works.

1.21 ELECTRICAL INSTALLATION

A. Measurement

Electrical installations shall be measured at the units shown in the BOQ for the concerned item.

B. Payment

1. General

Rates for installations generally shall include for:

- a. Identification plates, discs, labels and key charts in the Arabic and English languages
- b. Testing and commissioning including the provision of instruments, appliances, lighting and attendance
- c. Operating and Maintenance manuals in English language
- d. Colour coding
- e. Marking out
- f. Assembly, fitting and jointing component parts
- g. Patterns, molds, templates and the like
- h. Cutting away and making good and all other necessary builders work
- i. Painting
- j. Fixing including, screws, bolts and the like.

2. 6.6 KV Motor Control Center (MCC)

Rates for 6.6 KV, form four, MCC shall include for

- a. 7.2 KV Vacuum circuit breakers, Bus coupler with electrical and mechanical interlock, 1200A, 6.6KV, 3 phase 65KA busbar
 - b. Motor soft starters, contactors, relays, selector switches, pushbuttons, controls, free contacts, auxiliaries, emergency push button close to each motor
- C Power factor correction capacitors to improve the power factor better than 0.95, capacitor banks, protection breakers, contactors, microprocessor control, the compartment of each pump shall contain all related protection breakers,

- starters, contactors, power factor correction capacitors and controls related to that pump
- d. 225KVA, 6.6/.4KV pad mounted transformer, to be installed outdoor , price shall include load break switches, low voltage panel and protection breakers, fence and base.
 - e. Grounding, digital metering and instrumentation, Digital motor and monitoring and protection Relay.
 - f. Cabinets, anti condensation heaters, ventilation fan, and all accessories
3. 400V Submain Distribution panels (SMDB) ,Distribution Boards, External lighting panel, etc.
- a. Rates of SMDB , shall include busbars, MCCB's, cabinets, instrumentation, cable glands and all needed.
 - b. Rates of External lighting panel (SPEL), and panel DBC shall include controls ,contactors, , photocell, breakers, busbars, cabinets and all needed.
 - C. Rates of branch distribution panels shall include breakers, busbars, cabinets and all needed.
4. 6.6KV cables, 600V cables and street lighting cables
- Rates for cables shall include for:
- a. Excavation, backfilling, protection blocks, warning tapes, conduits, installation, connection, cable trays with suitable size (where applicable)
5. Feeding wires and cables for distribution panels
- Rates of feeding wires and cables for distribution panels shall include:
- a- Conduits, boxes, wires, installations and all needed.
6. Lighting Points
- Rates for Lighting and Fire alarm points shall include for:
- a. All conduits, conduit fittings, wiring, pull and junction boxes
 - b. All types of switches
 - c. The connection to the corresponding panel board.
7. Power and Telephone Socket Outlet , A/C and Fan feeding point and Junction Boxes
- Rates for Socket outlet points and junction boxes shall include for:
- a. All conduits, conduit fittings, wiring and junction boxes
 - b. All types of sockets and isolators.
 - c. The connection to the corresponding panel board.
 - d. In addition to above, price of RJ11 & RJ45 telephone and network outlets, shall

include RJ11& RJ45 modules in one grid, 2 module outlet, 4UTP cable up to network patch panel and telephone cable up to related TC.

8. Lighting Fixtures

Rates for Lighting Fixtures shall include for:

- a. The supply and fixing of the enumerated items
- b. All accessories relevant to the item
- c. Lamps unless otherwise described
- d. Any necessary supports.

9. Lighting Poles

Rates for the lighting poles shall include all as shown on the drawings including :

- a. Excavation for pole bases
- b. The concrete base
- c. The earthing rod for each pole
- d. The lighting fixture
- e. Fuses, wires.

10. Grounding and lightning system

Rates for the grounding system shall include

- a. Earth pit and earthing rod
- b. Earth lead and inspection manhole
- c. All needed to achieve an earth resistance better than 2 ohm.

Rates for the lightning system shall include

- a. Lightning roof meshes and lightning roof aerials.
- b. Down Conductors and testing points
- c. Earth pit and earthing rod
- d. Connection of all metallic equipment on roof to the system

11. Fire alarm control panel

Rates for the Fire alarm control panel shall include

- a. batteries and charger

12. Telephone Cables

Rates for telephone cable runs shall include for:

- a. The supply and fixing of the enumerated cables
- b. Conduits and all accessories relevant to the item, e.g., clamps, brackets, etc.
- c. Warning tape for underground telephone cables
- d. The connection from both sides
- e. All earthworks and concrete works associated with the installation of cables, including concrete blocks required for the telephone cable installation.

1.22 INSTRUMENTATION WORKS

A. Measurement

Instrumentation installations shall be measured at the unit shown in the BOQ for the concerned item.

B. Payment

1. General

Rates for installations generally shall include for:

- a. Identification plates, discs, labels and key charts in the Arabic and English languages
- b. Testing and commissioning including the provision of instruments, appliances, and attendance
- c. Operating and Maintenance manuals in English language
- d. Color coding
- e. Marking out
- f. Assembly, fitting and jointing component parts
- g. Patterns, molds, templates and the like
- h. Cutting away and making good and all other necessary builders work
- i. Painting
- j. Fixing including, screws, bolts, any support or structure needed to fix the instrument and the like.

2. Instrumentation system in Zatory Pump station

Rates for the Instrumentation system in Zatory Pump station shall include

- a. All Instrumentation sensors, transducers for all equipment and functions shown on drawings
- b. Instrumentation and sensor cables up to related PLC
- c. Ultra sonic level meter (0-5m) to be fixed on water reservoir.

- d. All Field and remote indicators and alarms
- e. Selector switches, hand switches, level and flow meter indicator.
- f. Flow meter sensor cable , Connection of the flow meter and calibration (the price of the flow meter shall be included in the Yard Piping above)
- g. Connection to PLC station

3. Instrumentation systems in Um El Lulu and Hofa Reservoirs

Rates for the Instrumentation systems in Um El Lulu and Hofa Reservoirs shall include

- a. All Instrumentation sensors, transducers for all equipment and functions shown on drawings
- b. Instrumentation and sensor cables up to related PLC
- c. Ultra sonic level meter to be fixed on water reservoir.
- d. All Field and remote indicators and alarms
- e. Selector switches, hand switches, level and flow meter indicator.
- f. Flow meter sensor cable , Connection of the flow meter and calibration
- g. Connection to PLC station

4. PLC/RTU station

Rates for the PLC/RTU station shall include

- a. PLC modules including CPU, power supply, I/O modules, Communication module
- b. GPRS modems with the required quantity to establish GPRS telemetry system ,
- c. Connection and co ordination with cellular phone company (fast Link) d.
- e. Cabinets, connection , programming

5. SCADA system at control center

SCADA system at control center shall include

- a. SCADA system to operate Zatory pump station and related reservoirs remotely, (manual and automatic), the system should be monitored and controlled on PC screens.
- b. Mimic panel as described in specifications
- c. 24 port data switch, 2 No. Pentium 4 PC's,
- e. 5KVA on line UPS for 15 minutes, full load
- e. Connection, programming and commissioning.

1.22 ROAD WORKS

A. Measurement

Measurement of road works items shall be in square meters.

B. Payment

Rates for road work items shall include for;

1. Preparation of subgrade to receive works
2. Spreading to the required thicknesses
3. Leveling and compacting to the required elevations, falls and cross falls.

1.23 LUMP SUM ITEMS

A. Measurement

Measurement for payment of the following items shall be on a lump sum basis;

1. Demolition and Modifications

B. Payment

1. Price and Payment of the lump sum items for Demolition and Modifications shall be full compensation of all works necessary to complete the works as specified and shown on the drawings inclusive of demolishing, excavation, removal, installing pipes, testing commissioning and cleaning inclusive of all applicable items mentioned in item 1.02 A above.
2. Payment of the lump sum price bid in the BOQ for the supply and installation of Furniture and Equipment shall be full compensation for all costs associated with the purchase, delivery and installation of all specified furniture as stated in the relevant drawings and schedules, and/or as specified.

1.24 CONTINGENCY PROVISIONAL SUM

A. Measurement

1. A contingency Provisional Sum amount has been provided in the BOQ to cover unforeseen Variation Order contingency costs that arise during the construction phase.

1.25 LANDSCAPING

A. Measurement

1. Measurement of plantation including its temporary support shall be by the number

B. Payment

1. The rate for the plantation shall include for preparation of soil, excavation for plantation, supply of plants, temporary supports, plantation and maintenance and replacement of unsuccessful plants during maintenance period
END OF SECTION

SECTION 01035

CONTROL OF WORK

PART 1: GENERAL

- A Furnish pipeline, pump station and equipment which will be efficient, appropriate and sufficient to secure a satisfactory quality of Work and a rate of progress which will insure the completion of the Work within the time stipulated in the Tender Form. If, at any time, such pipeline, pump station and equipment appears to the Engineer to be inefficient, inappropriate or insufficient for securing the quality of Work required or for producing the rate of progress aforesaid, the Engineer may order the Contractor to increase the pipeline and/or equipment and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the Work and rate of progress required. All pipeline, pump station and equipment components or parts including, but not limited to, mufflers, exhausts, lights, signals and warning and safety devices shall be maintained in proper working order.

1.02 PRIVATE AND PUBLIC LAND

- A Private or public lands shall not be entered or occupied by the Contractor, except by written permission of the land owners. Contractor with assistance by Employer shall get the most recent survey drawings from the Land Survey Department.

1.03 LOCATION OF WORKS

- A The Works shall be located substantially as indicated on the Drawings, but the Engineer reserves the right to make such modifications in locations as may be found desirable during construction to avoid interference with existing structures or for other valid reasons.

1.04 WORK SITE

- A The Work Site shall be the areas designated on the Drawings and between the right of way limits of public properties, streets and highways or as otherwise noted where pipelines are to be installed as shown on the Drawings. The Contractor shall obtain the latest version of Lands Department Drawings and WAJ Drawings to verify that no work shall be constructed on private lands unless the land was acquired by the Employer or permission was obtained by the Employer.
- B Confine the pipeline pump station, equipment and stores necessary for execution of the Works to the work Site indicated on the Drawings and any additional Work Sites secured solely by the Contractor. Provide reasonable facilities for access to the Site and any additional Work Sites for any person or vehicle authorized by the Engineer.
- C Make arrangements for all additional Work Sites in the vicinity of the Works or

elsewhere for the Contractor's site compound, offices for the Engineer, and for any additional lands required for construction purposes and access, apart from access along public streets. Apart from transport to and from these areas, confine all local operations under the Contract to these areas.

- D Before entering any Work Site, give 10 days notice to the Engineer in writing. Publish in a local newspaper, notices for each owner and occupier or Authority having charge over the Work Site. Before entering any additional Work Sites obtain and forward to the Engineer a copy of the written consent of the owner and occupier or authority having charge over the land and stating the purposes for which such land is to be used and defining the extent and period of occupation for which such consent is granted.
- E Restrict access to the Work sites to public rights of way, as otherwise indicated on the Drawings, or such alternative access as may be acceptable to the Engineer. Access to the Site shall be obtained only by such routes as are acceptable to the Engineer. Ensure that persons employed by Contractor or any Sub-contractor on the Site do not trespass beyond the Site and the routes so utilized.
- F Take sufficient precautions to prevent the run-off or polluting substances such as fuels, oils, or other polluting materials harmful to humans and the environment.
- G Provide access to Work Site for other Contractors for the purpose of carrying out concurrent Work at contract interfaces in the Project or other projects in the area.

1.05 SITE CONDITIONS

- A All levels shown on the Drawings refer to mean sea level Jordanian datum. A list of Surveying Reference Points has been prepared including their description and levels relative to this datum.
- B Before commencing setting out, check all survey stations and survey reference points in the vicinity of the Site to be used to determine that each survey station and bench mark is in its original position and condition.
- C Check the accuracy of survey reference points in the vicinity of the Site to ensure that they conform with at least two other listed survey reference points. The leveling loop closing error shall be within 6 mm/km before adjustment.
- D Inform the Engineer in writing of the result of these survey checks and whether such survey reference points and survey stations are in agreement or not.
- E Provide all survey and measuring instruments of every kind necessary for the execution of the Works.

1.06 TEST PITS

- A Dig test pits, by hand if necessary, for the purpose of locating underground utilities or structures in advance of the construction. Pits shall be excavated with the knowledge of

the Engineer. Backfill and compact to original density test pits immediately after their purpose has been satisfied and restore the surface in a manner satisfactory to the governing authority and the Engineer.

1.07 OPEN EXCAVATIONS

- A Safeguard all open excavations whether in roadways or cross country areas by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons, and damage to property. Provide suitable and safe bridges and other crossings for accommodating travel by pedestrians, workmen and public and private vehicles. Pedestrian access must be maintained at all times. Remove bridges provided for access during construction when no longer required. The length or size of excavation shall be controlled by the particular surrounding conditions. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, and requiring that the trench shall not remain open overnight. In all streets, roads, or footpaths placement of excavated material next to the trench will not be allowed. The Contractor will be required to haul excess material to a storage area where it will be kept temporarily, until needed for backfilling.
- B Do not open or excavate any street, way or public or private place until all necessary permits have been obtained, all materials and equipment required for construction are on hand, and existing underground utilities have been located by the Contractor.

1.08 CARE AND PROTECTION OF PROPERTY

- A Provide all protection for the preservation of all public and private property, and use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Work restore such property to a condition similar to that existing before the damage was done, or make good the damage in another manner acceptable to the Engineer.

1.09 MAINTENANCE OF TRAFFIC

- A Unless permission to close a street is received in writing from the proper authority, maintain all vehicular and pedestrian traffic at all times. Where permission is received for re-routing traffic or closing streets, the interruption of pedestrian and vehicular traffic shall cause a minimum of disruption and inconvenience. Seek information on and comply with all requirements and recommendations of the Traffic and/or Police Authority or Directorate regarding traffic safety measures, control, rerouting and road closure.
- B In those streets which have to be left open to traffic the length of trench open at any time shall not exceed 100 meters. Refer to Section 02222 for heavily congested areas and where maintaining two-way traffic is difficult, open trench shall not exceed 50 meters. Irrespective of any previous agreements, obtain all necessary permits as specified in Paragraph 1.12 herein.

- C Where normal access to properties cannot be maintained, arrange with the owners and occupiers of such properties, alternative temporary access and submit details of such agreed temporary access arrangements to the Engineer in writing before occupying the Work Sites.
- D The representatives are listed at the end of this Section.

1.10 PROTECTION AND RELOCATION OF EXISTING PUBLIC UTILITIES

- A The Authorities responsible for public utility services in the Project Area and their representative are listed at the end of this Section. Contact these representatives as required to secure needed information, approvals, and permits.
- B Some, but not all, of the existing utilities are shown on the drawings. In general, other utilities will not be relocated. However, in some cases if that is required the Contractor will have to obtain written approval from the owner of that utility. In such cases, the Contractor shall submit to the Engineer for approval a layout showing type of service, location, size, elevation and recommendation for relocation as required. The Contractor shall protect all existing facilities and services affected by the Works of this Contract.
- C Authorities shall be notified, weekly or more often as necessary, of the construction schedule with regard to exposing known services. Services encountered during the excavation work shall be uncovered and identified, and the Authority shall be notified. Where so required by the Authority, operations shall not proceed until the Authority is represented on Site.
- D Exploratory excavation by hand in addition to any previously dug test pits shall be performed so as not to damage the services and to expose all identified services in advance of general excavation. Protect such services in advance of general excavation. Protect such exploratory excavation until the general excavation meets this excavation, all to the satisfaction of the Engineer.
- E In the case and whenever the Contractor has incurred accidental damage to any of the local utilities he must immediately inform the owning agency and follow their instructions for its expedient restoration.

1.11 PROTECTION OF ANTIQUITIES AND ARCHAEOLOGICAL REMAINS

- A No requirement of the Specification regarding the disposal of material arising from site clearance or excavation shall override any provision in the Conditions of Contract as to the discovery or ownership of fossils, coins, articles of value or antiquity or anything of geological or archaeological interest found on the Site.
- B Notify the nearest Office of the Department of Antiquities (DOA), the Engineer, and local police immediately upon discovery of items of geological or archaeological interest. (Follow the DOA instructions for such cases.)

1.12 PERMITS, APPROVALS AND ASSOCIATED FEES

- A Contact representatives of all authorities as required, prepare and submit shop drawings as required, and perform all other work necessary to secure needed information, permits and approvals.
- B Liaise with the Engineer and Employer as required to enable the Employer to assist in the application process for all permits and approvals.
- C All applications for permits and approvals will be made by the Contractor on behalf of the Employer. The permits and approvals will be granted to the Employer on behalf of the Contractor.
- D Possess a valid permit from the appropriate local authority and from the Traffic and/or Police Authority or Directorate before commencing any Work in public streets. The application for permits require the periods of occupation to be stated by the Contractor.
- E Possess approval in writing from the Owner before commencing crossing and/or diversion of any irrigation canal, irrigation channel and/or drain.
- F The procedures for obtaining permits and approvals are normally lengthy involving numerous meetings, sometimes outside normal working hours.
- G No separate payment will be made for the Work performed by the Contractor in connection with permits and approvals, but such cost shall be incidental to other Work performed under this contract.

1.13 TREES AND SHRUBS

- A Unless otherwise shown on the Drawings, do not remove or trim trees or shrubs without prior written permission of the Engineer or the property owner. Employ proper methods and precautions to protect and preserve trees and shrubs at all times. Trees and shrubs that are damaged beyond restoration by construction operations which have not been approved for disturbance by the Engineer shall be replaced at the Contractor's own expense by fresh nursery trees and shrubs of the same species, size and quality as approved by the Engineer. The Contractor may compensate the Owner for damaged trees or shrubs in lieu of replacement.

1.14 COOPERATION WITHIN THIS CONTRACT

- A At the request of the Engineer, provide such labor and tools, stakes and other materials as are reasonably required to assist the Engineer in measuring, supervising, checking, testing, examining or setting out the Contractor's Work in any way whatsoever at any time within the regular working hours.

1.15 NUISANCE CAUSED BY DUST AND THE LITTERING OF PUBLIC AREAS

- A Be responsible for, and do not create any nuisance by littering the public streets with

earth, mud, debris, water and the like, falling off vehicles used for the purpose of this Contract. Failure to comply with this requirement will permit the Engineer to employ laborers or take other necessary action to comply with anti-littering requirements, and the cost incurred thereby will be deducted from any moneys due or to become due to the Contractor.

- B The Contractor shall perform dust control operations, in an approved manner, whenever necessary or when directed by the Engineer, even though other work on the project may be suspended. Dust control shall be generally accomplished by the use of water; however, the use of calcium chloride may be used when necessary to control dust nuisance.
- C Calcium chloride shall conform to AASHTO M144, Type I, except the requirements for “total alkali chlorides” and other impurities shall not apply.
- D The Contractor’s methods of controlling dust shall meet all air pollutant standards as set forth in the Hashemite Kingdom of Jordan.

1.16 PREVENTION OF NOISE

- A Keep noise and disturbance to a minimum. Attention is directed to the proximity of Work Sites to residences and buildings in continuous use. Stop operation of any particular item of equipment whenever, in the opinion of the Engineer, necessary steps could be taken to eliminate or minimize the noise or disturbance. Compressors and generators shall be isolated, and acoustically screened to reduce all noise emissions.

1.17 PROTECTION OF CONSTRUCTION AND EQUIPMENT

- A Provide security watchmen as required for the protection and security of the Work during the period of this Contract.
- B Carefully protect all new Work from damage in any way. Reconstruct all damaged Work to the Satisfaction of the Engineer.
- C Protect all structures and equipment in a manner satisfactory to the Engineer. Should any pipeline, equipment, or underground structure become heaved, cracked, or otherwise damaged, repair all such damaged portions to the satisfaction of the Engineer.

1.18 CLEAN UP

- A During the course of the Work, keep the Work Site in as clean and neat a condition as possible. Do not dump unwanted debris on any vacant plot of land, roadside, or in any drains. Remove and dispose off-site at dumping grounds acceptable to the appropriate authorities all unwanted debris from the Site at approved dumping ground. Do not leave empty containers or receptacles in the open that are capable of forming breeding places for insects and attracting rodents.

- B At the conclusion of the Work, leave the entire Work Site in a neat, orderly and clean condition. Perform all necessary cleaning, making good, and touching up that may be require to leave all finished surfaces, and equipment in acceptable condition, in accordance with the full intent and meaning of these Specifications.

1.19 LIST OF LOCAL GOVERNMENT, PUBLIC UTILITY AND NATIONAL AUTHORITIES

- A The information provided in the following list was accurate when compiled but, due to the nature of the information, it is subject to change.
1. Northern Governorates Water Authority
 2. Water Authority Local Irbid, Jerash and Mafrq Offices
 3. National Electricity Company Local Office in Irbid and Mafrq
 4. Jordan Telecommunication Company Local Office in Irbid and Mafrq
 5. Department of Antiquities
 6. Department of Land and Survey
 7. The Main and Local offices of The Power Distribution Company
 8. The Ministry of Public Works and Housing
 10. The Municipalities of The Towns where the Pipeline Located along the Pipeline Alignment.
 11. Any Other Offices of Agencies Relevant to the Projects

END OF SECTION

SECTION 01036

ENVIRONMENTAL PROTECTION

PART 1: GENERAL

1.01 SCOPE OF WORK

- A The work covered by this Section consists of furnishing all labor, materials, and equipment and performing all work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humans; destroy or lead to the destruction of archaeological sites, pollute or lead to the pollution of the water source, cause disruption of traffic, lead to the change of land use, or degrade the utility of the environment for aesthetic and/or recreational purposes.
- B The control of environmental pollution requires consideration of air, water and land, and involves management of noise and solid wastes, as well as other pollutants.
- C The Contractor shall schedule and conduct his work in a manner that will minimize the erosion of soil in the area of the work. He shall provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, and seeding, mulching or other special surface treatment as are required to prevent silting and muddying of streams, wadis, etc.
- D These specifications are intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines, it is left to the Contractor to decide what specific construction techniques he may best utilize to meet or exceed these guidelines.

1.02 APPLICABLE REGULATIONS

- A The Contractor and his subcontractors shall comply with all applicable and current laws and regulations concerning environmental pollution control and abatement of the Hashemite Kingdom of Jordan.

1.03 NOTIFICATION

- A The Engineer will notify the Contractor in writing of any non-compliance with foregoing provisions or of any environmentally objectionable acts and corrective action to be taken. The Contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Contractor or his authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop order shall be made the subject of a claim for extension

of time or for excess cost or damages by the Contractor unless it is later determined that the Contractor was in compliance. The Owner shall have the right to ask for compensation for any subject that was destroyed by the Contractor and deemed unrecoverable.

1.04 IMPLEMENTATION

- A Prior to commencement of the work the Contractor will meet with the Engineer to develop mutual understanding relative to compliance with this provision and administration of the environmental pollution control program.
- B The Contractor shall remove temporary environmental control features as needed and incorporate permanent control features into the project at the earliest practicable time.

PART 2: PRODUCTS

(NONE THIS SECTION)

PART 3: EXECUTION

3.01 EROSION CONTROL

- A The Contractor shall provide means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures, such as siltation basins, hay check dams, and other equivalent techniques, will be used as appropriate. Offsite surface water shall be diverted around the site to a downstream channel ahead of siltation barriers. Flow of surface water into excavated areas shall be prevented. Ditches around construction areas shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled and the ground surface restored to original condition.

3.02 PROTECTION OF STREAM AND SPRINGS

- A Care should be taken to prevent or reduce to a minimum, any damage to any spring, stream or wadi from pollution by debris, sediment or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, or that contains oils or sediment that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Such water will be diverted through a settling basin or filter before directed into the stream. Debris shall be disposed of in a site approved by the Owner.
- B The Contractor shall not discharge water from dewatering operation directly into any live or intermittent stream, channel, wetlands, surface water or any storm sewer. Water from dewatering operation shall be treated by filtration, settling basins, or other approved methods of sediment contained in the water to allowable levels.
- C All preventative measures shall be taken to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with an approved contingency action drawing.

3.03 PROTECTION OF LAND RESOURCES

- A It is intended that the land resources within the project boundaries and inside the limits of permanent work will be restored to a condition after completion of construction that will appear to be natural and not detract from the appearance of the project. Insofar as possible, the Contractor shall confine his construction activities to areas shown on the Drawings.
- B Outside of areas requiring earthwork for the construction of the new facilities, the Contractor shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without special authority. No ropes, cables or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineer. Where such special emergency use is permitted, the Contractor shall first adequately wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.
- C Where trees may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment, dumping or other operations, the Contractor shall protect adequately such trees by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly before beginning operation near them.
- D Any trees or other landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the Contractor's expense. The Engineer will decide what method of restoration shall be used and whether damaged trees shall be treated and healed or removed and disposed of.
- All scars made on trees by equipment, construction operations, or by the removal of limbs larger than 25 mm in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.
- E The location of the Contractor's storage, and other construction buildings, required temporarily in the performance of the work, shall require written approval of the Engineer. The preservation of the landscape shall be an imperative consideration in the selection of all temporary facilities. The location of storage facilities shall be submitted for approval of the Engineer.
- F If the Contractor proposes to construct temporary roads or embankments and excavation for work area, he shall submit the following for approval at least 10 days prior to scheduled start of such temporary work.
1. A layout of all temporary roads, excavations and embankments to be constructed within the work area.

2. Detail of road construction.
 3. Drawings and cross sections of proposed embankments and their foundations, including a description of proposed materials.
 4. A drawing showing the proposed restoration of the area. Removal of any trees and shrubs outside the limit of existing clearing area shall be indicated. The drawing shall also indicate location of required guard posts or barriers required to control vehicular traffic passing close to trees and shrubs to be maintained undamaged. The drawing shall provide for the obliteration of construction scar as such and shall provide for a reasonable natural appearing final condition of the area. No unauthorized road construction, excavation or embankment construction including disposal areas will be permitted.
- G. The Contractor shall remove all signs of temporary construction facilities such as haul roads, work area structures, foundation of temporary structures, stockpiles of excess or waste materials, or any other vestiges of construction as directed by the Engineer. It is anticipated that excavation, filling, plowing of roadways will be required to restore the area to near natural condition.
- H All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

3.04 PROTECTION OF AIR RESOURCES

- A Burning. The use of burning at the project site for the disposal of refuse and debris will not be permitted.
- B Dust Control. The Contractor will be required to maintain all excavation, embankment, stockpiles, access road, waste areas, borrow area, and other work areas within or without the project boundaries free from dust which could cause a hazard or nuisance to others.
- C An approved method of stabilization consisting of sprinkling or other similar method will be permitted to control dust. The use of petroleum product or calcium chloride is prohibited.

3.05 PROTECTION OF IRRIGATION FACILITIES

- A The Contractor shall protect existing irrigation channels and irrigation pipes from damage and shall repair such facilities as expediently as possible if damage is incurred.

3.06 NOISE CONTROL

- A The Contractor shall make every effort to minimize noises caused by his operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with regulations.

3.07 PROTECTION OF ANIMALS

- A The Contractor shall be cognizant of existing animal herds in the project area and endeavor to prevent injury to them as a result of his equipment operation, unprotected excavations, and other activities.

END OF SECTION

SECTION 01045

CUTTING, CORING AND PATCHING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers the cutting, coring, rough and finish patching of holes and openings in existing construction.
- B. All cutting, coring, and rough patching shall be performed by the Contractor. Finish patching shall be the responsibility of the Contractor and shall be performed by the trade associated with the application of the particular finish.

1.02 RELATED WORK

- A. Pipe penetration assemblies are included in Section 01172.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Concrete and grout for rough patching shall be as specified in Divisions 3 and 4.
- B. Materials for finish patching shall be equal to those of adjacent construction.

PART 3 EXECUTION

3.01 GENERAL

- A. All cutting and coring shall be performed in such a manner as to limit the extent of patching.
- B. All holes cut through concrete and masonry walls, slabs or arches shall be core drilled unless otherwise approved. No structural members shall be cut without approval of the Engineer and all such cutting shall be done in a manner directed by him. No holes may be drilled in beams or other structural members without obtaining prior approval. All work shall be performed by mechanics skilled in this type of work.
- C. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown. Finish patching shall match existing surfaces as approved.

3.02 CORING

- A. Coring shall be performed with an approved non-impact rotary tool with diamond core drills. Size of holes shall be suitable for pipe, conduit, sleeves, equipment or mechanical seals to be

installed.

- B. All equipment shall conform to OSHA standards and specifications pertaining to plugs, noise and fume pollution, wiring and maintenance.
- C. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.
- D. Slurry or tailings resulting from coring operations shall be vacuumed or otherwise removed from the area following drilling.

3.03 CUTTING

- A. Cutting shall be performed with a concrete wall saw and diamond saw blades of proper size.
- B. Provide for control of slurry generated by sawing operation on both sides of wall.
- C. When cutting a reinforced concrete wall, the cutting shall be done so as not damage bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.
- D. Adequate bracing of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for partial cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.
- E. Provide equipment of adequate size to remove cut panel.

END OF SECTION

SECTION 01170

SPECIAL PROVISIONS

PART 1: GENERAL

1.01 GENERAL OBLIGATIONS OF THE CONTRACTOR

- A General obligations of the Contractor shall be as set forth in the Contract Documents. Unless special payment is specifically provided in the payment paragraphs of the specifications, all incidental work and expense in connection with the completion of work under the Contract will be considered a subsidiary obligation of the Contractor and all such costs shall be included in the appropriate items in the Tender Form in connection with which the costs are incurred.

1.02 SITE INVESTIGATION

- A The Contractor shall satisfy himself as to the conditions existing within the project area, the type of equipment required to perform the work, the character, quality and quantity of the subsurface materials to be encountered insofar as this information is reasonably ascertainable from an inspection of the site, as well as from information presented by the Drawings and Specifications. Any failure of the Contractor to acquaint himself with the available information will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work. The Owner assumes no responsibility for any conclusions or interpretation made by the Contractor on the basis of the information made available by the Owner. Geotechnical studies appended in the Appendix, likewise, are solely for the Contractor's information only.

1.03 COORDINATION WITH LOCAL AGENCIES

- A The Contractor shall supply the Local Authorities (see Section 01035) with the following information.
1. A list of streets and intersections where work will be in progress to be supplied at intervals as required by the Engineer.
 2. Areas where approved detours are in effect.
 3. Immediate notification of any drain or water main breaks.
- B The Contractor will be required to maintain traffic as specified or as directed by the Engineer.
- C The Contractor shall maintain pavement as specified in Section 02510 and shall provide the road authority with an address at which he can be contacted when he is not at the site. Upon notification by the Owner or the Engineer the Contractor shall promptly make such repairs as necessary to paved surfaces.

- D The Contractor shall notify all area residents in advance of any construction operations, street closure or interruption of water service using the notices at the end of this section.

1.04 PUBLIC UTILITIES

- A The Contractor shall comply, as applicable, with WAJ General Technical Specification for Sewerage Works (1995), Section 122 regarding Notices of Commencement of Work and cooperation with Authorities.
 - 1. The Contractor shall notify public utility companies in writing at least 5 work days (excluding Fridays and legal holidays), but not more than 30 days before excavating in areas where underground utility plant (pipes, cables, manholes, etc) exist.
 - 2. The Contractor shall be responsible for providing the Utility Owners with a schedule of his activities in areas where the utilities exist.
 - 3. The Contractor shall immediately notify utility Owners of any damage to their utilities resulting from construction operations.

1.05 PROGRESS SCHEDULE

- A The Contractor shall submit a progress schedule before starting any work in accordance with the General Conditions.
- B The Contractor shall review the progress schedule with the Engineer periodically. Such review shall be made on a monthly basis or more frequently as required by the Engineer. The progress schedule shall be updated and submitted with the request for monthly progress payments.

1.06 PERMITS

- A The Contractor shall be required to obtain all necessary permits for proper execution of all phases of the project. The Contractor shall fill out all forms and furnish all drawings required to obtain the permits. A copy of the approved permit shall be submitted to the Engineer. All fees associated with these permits shall be paid by the Contractor as part of the project. Work shall not commence on any phase of the work requiring a permit until the permit is obtained.
- B The Contractor shall obtain required street opening permits for excavations within streets or sidewalk areas.

1.07 NOISE LIMITATIONS

- A All equipment to be furnished under this Contract, unless specified otherwise in the technical specifications, shall be designed to insure that the sound pressure level does not exceed 85 decibels over a frequency range of 37.8 to 9600 cycles per second at a distance of one meter from any portion of the equipment, under any load condition, when tested using standard equipment and methods. Noise levels shall include the noise from the motor.

Mufflers or external baffles shall not be acceptable for the purpose of reducing noise. Data on noise levels shall be included with the shop drawing submittal.

1.08 WEATHER PROTECTION

- A In the event of inclement weather, the Contractor and subcontractors shall protect the Work and materials from damage or injury from the weather. If, in the opinion of the Engineer, any portion of the Work or materials has been damaged by reason of failure on the part of the Contractor or subcontractors to so protect the Work, such Work and materials shall be removed and replaced with new materials and Work to the satisfaction of the Engineer.
- B The Contractor's special attention is drawn to fact that at certain times of the year the location in which the Works are to be constructed can be subjected to sand/dust storms. These weather conditions produce a very dusty/dirty environment and the Contractor shall take all necessary precautions to ensure the successful completion of operations when performing such work as welding, painting, fiber glass duct jointing, the application of waterproofing and weatherproofing systems, the assembly of mechanical and electrical equipment and all other aspects of the work that could be adversely affected.

END OF SECTION

(See attached notices)

NOTICE
OF STREET CLOSURE TO CONSTRUCT
WATER SYSTEM IMPROVEMENTS

We regret to inform you that we have to close your street temporarily from motor traffic to be able to construct water system improvements.

FROM _____ TO _____ ON _____ 200

Your construction contractor will try to make this necessary interruption as short as possible.

We suggest that you refrain from parking private vehicles in the street as well as traveling in the immediate vicinity of the construction zone during the duration of the pipeline construction. If you wish additional information, please call our office at _____ .

Your understanding and cooperation is hereby acknowledged and appreciated.

THANK YOU

PROJECT No. ____
NORTHERN GOVERNORATES
EASTERN PRIMARY TRANSMISSION SYSTEM PROJECT

Contractor Name

Phone Number

Address

NOTICE
OF INTERRUPTION IN WATER SERVICE

We regret it will be necessary to temporarily interrupt water service to your premises:

FROM _____ TO _____ ON _____ 200

This temporary interruption in service will be as brief as possible, but is necessary to facilitate improvements to the Water Supply Project.

We suggest that you fill containers with any water that you may require during the shutdown. If you wish additional information, please call our office at _____ .

Your understanding and cooperation is hereby acknowledged and appreciated.

THANK YOU

PROJECT No. ____
NORTHERN GOVERNORATES
EASTERN PRIMARY TRANSMISSION SYSTEM PROJECT

Contractor Name

Phone Number

Address

SECTION 01171

ELECTRIC MOTORS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Motors, up to 200 Hp, furnished under other Sections, shall be in conformance with the requirements listed in this Section unless otherwise noted.

1.03 SUBMITTALS

- A. Submittal of motor data for acceptance shall include complete nameplate data and test characteristics in accordance with NEMA Standard MG1-12.54 "Report of Test Form for Routine Tests on Induction Motors" and, in addition, the following for motors typical of the units furnished:

1. Efficiency at 1/2, 3/4 and full load
2. Power factor at 1/2, 3/4 and full load
3. Motor outline, dimensions and weight
4. Descriptive bulletins, including full description of insulation system
5. Bearing design data
6. Special features (i.e., space heaters, temperature detectors, etc.)
7. Power factor correction capacitor rating and type.

1.04 REFERENCE STANDARDS

- A. Institute of Electrical and Electronics Engineers (IEEE)
- B. National Electrical Manufacturers Association (NEMA)
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. Routine tests shall be performed on representative motors, and shall include the information described on NEMA MG1-12.54 "Report of Test Form for Routine Tests on Induction Motors". Efficiency shall be determined in accordance with IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors.

1.06 SYSTEM DESCRIPTION

- A. Motors specified herein are three phase, squirrel cage induction type for 1/2 Hp and above; single phase for less than 1/2 Hp; or DC motors.

PART 2 PRODUCTS

2.01 RATING

- A. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where shown on the Electrical Drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.
- B. The motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.0) service factor, under any condition of mechanical or hydraulic loading.
- C. All motors shall be continuous time rated suitable for operation in a 45 degrees C ambient unless noted otherwise.
- D. Specific motor data such as Hp, rpm, enclosure type, etc, is specified under the detailed specification for the equipment with which the motor is supplied.

2.02 ENCLOSURE TYPES

- A. Motors specified herein will conform to the following standard enclosure designs:
 - 1. Totally Enclosed Fan Cooled (TEFC)

2.03 NAMEPLATES

- A. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MGI-10.38 or MGI-20.60, as applicable.

2.04 CONDENSATION HEATERS

- A. Condensation heaters, where specified under the detailed mechanical specifications shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 Volt, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor lead junction box.

2.05 WINDING TEMPERATURE DETECTORS

- A. Winding temperature detectors, where specified under the detailed mechanical specifications for individual equipment shall be a factory installed, embedded, bi-metallic switch type with leads terminating in the main conduit box. This device shall protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts or ventilation failure. The switch shall have normally closed contacts. Not less than three detectors shall be furnished with each motor.
- B. Motors connected to variable frequency drives shall be equipped with winding temperature detectors.

2.06 SINGLE PHASE MOTORS

- A. Unless otherwise specified, motors smaller than 1/2 Hp shall be single phase, capacitor start. Small fan motors may be split-phase or shaded pole type if such are standard for the equipment. Wound rotor or commutator type single-phase motors are not acceptable unless their specific characteristics are necessary for the application.
- B. Motors shall be rated for operation at 115 Volts, single phase, 60 Hz.
- C. Locked rotor current shall not be greater than specified in NEMA Standard MGI-12.32, Design "N".
- D. Motors shall be totally-enclosed in conformance with NEMA Standard MGI-10.35. Small fan motors may be open type if suitably protected from moisture, dripping water and lint accumulation.
- E. Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.

2.07 THREE PHASE MOTORS-FRAMES 143T THROUGH 449T

- A. General
 - 1. Unless otherwise specified, motors 1/2 Hp and larger shall be 3 Phase, squirrel cage induction type.
 - 2. All motors 3/4 Hp and larger shall be a NEMA frame 143T or larger. 1/2 Hp motors and 3/4 Hp motors rated 1800 and 3600 rpm, shall be a 56 frame. Motors shall be designed and connected for operation on a 480 Volt, 3 Phase, 60 Hz alternating current system. Dual voltage (230/460) rated motors are acceptable.
 - 3. Unless otherwise required by the load, all motors shall be NEMA Design B, normal starting torque. Locked rotor kVA/Hp shall not exceed Code Letter G as described in NEMA Standard MG1-10.37 for motors 20 Hp and larger.
 - 4. Motors connected to variable frequency drives shall be inverter duty rated.

5. Motors shall be by U.S. Electrical Motors, Division of Emerson Electric Co., or equal.

B. Bearings

1. Anti-friction motor bearings shall be designed to be regreasable and initially shall be filled with grease suitable to ambient temperature of 45 degrees C. Bearings shall be ABMA Types BC or RN, heavy duty, or shall otherwise be shown to be suitable for the intended application in terms of B-10 rating life, Class M3 or better.
2. All grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type by the Alemite Division of the Stewart-Warner Corporation.

C. Insulation

1. Insulation systems shall be Class B or Class F, operated at Class B temperature rise and shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies and mechanical or thermal shock for 480 Volt motors. Provide 80 degree C, Class B rise or better by resistance at 100 percent load and provide a Class F insulation system, suitable for an ambient temperature motor operation of 0 to 40 degree C at no more than 3300 feet above sea level for medium voltage motors. This temperature rise shall be met when motors are operated and controlled with the VFD(s). The motor insulation system shall have full capability to handle the common mode voltage conditions imposed by the VFD.
2. Motors for outdoor service shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.
3. Insulation for inverter duty motor windings shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be injured when exposed to repeated pulse type waveforms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. Class H varnish shall be used.

D. Enclosures

1. Motors shall have a steel or cast iron frame, a cast iron or stamped steel conduit box, as specified below and a 1.15 service factor at [45] degrees C. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover. Motor leads shall be sealed with a non-wicking, non-hygroscopic insulating material. A frame mounted pad with drilled and tapped hole, not less than 1/4-in diameter, shall be provided inside the conduit box for motor frame grounding.
 - a. Totally enclosed fan cooled: TEFC motors shall have a steel or cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 45 degrees C, tapped drain holes (corrosion resistant plugs for frames 286T and smaller and

automatic breather/drain devices for frames 324T and larger) and upgraded insulation by additional dips and bakes to increase moisture resistance.

- b. Totally enclosed non-ventilated: TENV motors shall include the same rating and accessories as specified for TEFC motors.
- c. Explosion proof: Explosion proof motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 45 degrees C, tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and be UL listed for Class 1, Div. 1, Group D hazardous areas.
- d. Severe duty: Motors shall be of the corrosion resistant type conforming to motors designated by the manufacturer as "Corro-Duty", "Mill and Chemical", "Custom Severe Duty", or similar quality designation. Severe duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box and 1.15 service factor at [40] degrees C and tapped drain holes (corrosion resistant plug for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger).
- e. Weather Protected Type I motors shall have open drip proof characteristics with ventilating passages so constructed as to minimize the entrance of rain, snow and air-borne particles to the electric parts. Its ventilating openings shall be constructed as to prevent the passage of a cylindrical rod 3/4-in in diameter. Large motor frames greater than 364 shall also have corrosion resistant screens (guarded), shaft slinger, nipped lead gasket at the conduit box, gasketed severe duty conduit box, internal painting of air gap surfaces, encapsulated winding treatment for moisture resistance and space heaters.
- f. Weather Protected Type II motors shall have all of the features of Weather Protected Type I with its ventilating passages at both intake and discharge so arranged that high velocity air and air-borne particles blown into the machine by storms or high winds can be discharged without entering the internal ventilating passages leading directly to the electric parts.

E. Inverter Duty Rated Motors

1. Inverter duty rated: Motors for operation on variable frequency drives shall meet current power quality levels published in NEMA MG1, Part 31 (1993). Consideration shall be given to the primary factors of the variable frequency drive such as the modulation scheme (six-step, PWM, etc), the switching or carrier frequency and the type of power output devices utilized (IGBT etc). Consideration shall also be given to the installation methods such as output cable length, cable installation method, installation of output filters, etc. Enclosures shall be equal to those furnished for severe duty or explosion proof motors. Motor shaft and bearings shall be insulated. Internal service factor shall be 1.0 that of the nameplate. Unless otherwise noted provide enclosures suitable for "severe duty". Motors shall be furnished with an internal thermal switch. Ventilation system shall be designed for maximum heat

transfer. Stator laminations shall be stagger-stacked and stamped from high grade electrical steel to minimize eddy-current losses and heat build-up caused by inverter induced harmonics. Rotors shall be configured to minimize skin-effect heating.

F. Motor Efficiencies

1. Three phase motors rated 1 Hp and larger shall be of the premium efficiency type. Motors shall have a NEMA Nominal Efficiency not less than the values indicated below. Efficiency values shall be based on tests performed in accordance with IEEE

Publication No. 112, Method B. Motors with horsepower or rpm's not listed shall conform to comparable standards of construction and materials as those for listed motors.

2. Where State Energy Codes or Utility Company Energy Rebate Programs dictate higher efficiencies than those listed, the higher efficiency motors shall be furnished.

Full Load Efficiencies
 OPEN MOTORS

Hp	<u>3600 RPM</u>	<u>1800 RPM</u>	<u>1200 RPM</u>	<u>900 RPM</u>
	Minimum Nominal Efficiency	Minimum Nominal Efficiency	Minimum Nominal Efficiency	Minimum Nominal Efficiency
1.0	--	85.5	82.5	--
1.5	85.5	86.5	86.5	--
2.0	86.5	86.5	87.5	--
3.0	86.5	89.5	89.5	--
5.0	89.5	89.5	89.5	--
7.5	89.5	91.0	91.7	--
10.0	90.2	91.7	91.7	--
15.0	91.0	93.0	92.4	--
20.0	92.4	93.0	92.4	92.4
25.0	93.0	93.6	93.0	92.4
30.0	93.0	94.1	93.6	93.6
40.0	93.6	94.1	94.1	93.6
50.0	93.6	94.5	94.1	93.6
60.0	94.1	95	95.0	94.1
75.0	94.5	95	95.0	94.5
100.0	94.5	95.4	95.0	95.0
125.0	95.0	95.4	95.4	95.0
150.0	95.4	95.8	95.8	95.0
200.0	95.4	95.8	95.4	95.4

Full Load Efficiencies
ENCLOSED MOTORS

Nominal Hp	<u>3600 RPM</u>	<u>1800 RPM</u>	<u>1200 RPM</u>	<u>900 RPM</u>
	Minimum Nominal	Minimum Nominal	Minimum Nominal	Minimum
	<u>Efficiency</u>	<u>Efficiency</u>	<u>Efficiency</u>	<u>Efficiency</u>
1.0	80.4	85.5	82.5	83.5
1.5	85.5	86.5	87.5	84.9
<u>2.0</u>	<u>86.5</u>	<u>86.5</u>	<u>88.5</u>	<u>85.5</u>
3.0	88.5	89.5	89.5	85.7
5.0	89.5	89.5	89.5	89.9
<u>7.5</u>	<u>91</u>	<u>91.7</u>	<u>91.7</u>	<u>90.6</u>
10.0	91.7	91.7	91.7	90.3
15.0	91.7	92.4	92.4	90.7
<u>20.0</u>	<u>92.4</u>	<u>93.0</u>	<u>92.4</u>	<u>91.6</u>
25.0	93.0	93.6	93.0	91.8
30.0	93.0	93.6	93.6	92.7
<u>40.0</u>	<u>93.6</u>	<u>94.1</u>	<u>94.1</u>	<u>93.0</u>
50.0	94.1	94.5	94.1	93.4
60.0	94.1	95.0	94.5	93.3
<u>75.0</u>	<u>94.5</u>	<u>95.4</u>	<u>95.0</u>	<u>94.5</u>
100.0	95.0	95.4	95.4	94.7
125.0	95.4	95.4	95.4	95.1
150.0	95.4	95.8	95.8	<u>95.2</u>
<u>200.0</u>	<u>95.8</u>	<u>96.2</u>	<u>95.8</u>	<u>95.1</u>

G. Power Factor Correction Capacitors

1. All single speed motors over 5 horsepower (except motors powered from variable frequency drives) shall be provided with a heavy duty industrial type power factor correction capacitor selected, recommended and furnished by the motor manufacturer to raise the motor power factor to approximately 95 percent. For non-explosion-proof motors, the capacitor shall be mounted on the equipment base plate adjacent to the motor and shall be connected to the motor junction box with liquid tight flexible conduit. For explosion-proof motors, the capacitors shall be wall mounted in a non-hazardous area.
2. Capacitors shall be dry film or liquid insulated and shall be hermetically sealed in steel enclosures.
3. Each capacitor unit shall be furnished with three high interrupting capacity current limiting fuses. Fuses shall be equipped with "blown-fuse" indicators.

4. Capacitor enclosures shall be suitable for conduit connection. Covers shall be gasketed, bolt-on type.
5. Capacitors shall be UL listed.
6. Capacitors shall be by General Electric Co.; Square D Co. or equal.

H. Alternate Power Factor Correction Equipment

1. Units shall be designed to provide power factor correction in applications subject to the effects of harmonics.
2. Units shall consist of power factor correction capacitors equipped with series inductors. The units shall be tuned to just below the 5th harmonic frequency on systems with predominately 3 Phase loads.
3. Capacitors shall be NEMA rated and tested, shall be non-PCB dielectric, biodegradable, low toxicity, equipped with current limiting fuses, internal discharge resistors and fuse loss indicators. Fuses shall be capable of interrupting a short circuit of 100,000 Amps at 480 Volts, 3 Phase.
4. Inductors shall have low flux density and distributed gaps, copper windings, brazed connections, winding varnish impregnated and baked, Class 220 degrees C insulation with 80 degrees C rise.

END OF SECTION

SECTION 01172

PIPE PENETRATIONS

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required and install pipe penetration assemblies as shown. This Section covers materials for the various pipe penetration configurations.

1.02 SUBMITTALS

- A Submit to the Engineer, as provided in Section 01300, manufacturers' literature on all items to be furnished, installation instructions, and where applicable, fire rating and certified test results of the various components.

PART 2: PRODUCTS

2.01 PIPE SLEEVES

- A Unless otherwise shown all pipe sleeves shall be Schedule 40 galvanized steel pipe conforming to ASTM A53. Where indicated, provide a 50 mm minimum circumferential water stop welded to exterior of sleeve at its midpoint. Ends of sleeves shall be cut, ground smooth, and shall be flush with the wall or ceiling and extend 50 mm above finished floors. Sleeves to be sealed by caulking shall be sized as required. Sleeves to be sealed with mechanical seals shall be sized in accordance with the seal manufacturer's recommendations. Sleeves for insulated piping shall be sized as required.
- B The Contractor shall have the option to make external wall penetrations by means of a sleeve capable of being bolted directly to the formwork. Seal of the annular space between the carrier pipe and the sleeve shall be made by means of a confined rubber gasket and be capable of withstanding 25 bars of pressure. Sleeve shall be ductile iron with an integrally cast waterstop of 12.5 mm minimum thickness, 50 mm minimum height.

2.02 WALL CASTINGS

- A Unless otherwise shown, wall castings shall be ductile iron conforming to ANSI/AWWA A21.51/C151, thickness Class 53, diameter as required. Flanges and/or mechanical joint bells shall be drilled and tapped for studs where flush with the wall. Castings shall be provided with an intermediate 50 mm minimum circumferential flange/waterstop, integrally cast with or welded to the casting, located as follows: for castings set flush with walls located at the center of the overall length of the casting; for castings which extend through wall located such that it falls within the middle third of the wall.

2.03 SEALING MATERIALS

- A Mechanical seals shall be modular, adjustable, bolted, mechanical type consisting of

interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve. The seal shall be rated by the manufacturer for 25 bars of pressure. Mechanical seals shall meet all aspects of the specifications. Examples of such mechanical seals are as manufactured by Link-Seal, "C" series, Thunderline Corp. from Wayne, MI., or approved equal.

- B Caulking for iron, steel and copper piping shall consist of braided oakum or asbestos packing followed by poured molten soft virgin lead. Minimum length of lead segment shall be one half of pipe diameter, or 150 mm, whichever is less. Lead shall be flush with end of sleeve. Cooled lead shall be expanded with a caulking iron to form a water seal.
- C Caulking for PVC pipe shall meet all the requirements in paragraph B above except that lead wool, compacted to form a watertight seal, shall be used in place of molten lead.
- D Sealant shall be a two part foamed silicone elastomer. Examples of such sealant are manufactured by Dow Corning Co., product No. 3-6548 silicone R.T.V.; 3M brand fire barrier products caulk C.P. 25 and 3M brand putty 303; or Flame-Safe fire stop systems Fig. No. FS-500 by Thomas & Betts Corporation. Packing shall be a fire retardant pliable material, Fig. 310 by Sealtite Co., White Oakum W.S.-600 by American Manufacturing Co., or approved equal. Sealant bead configuration, depth and width shall be in accordance with manufacturer's recommendations.

2.04 MISCELLANEOUS MATERIALS

- A Bonding compound shall be Sikadur Hi-Mod epoxy by Sika Corporation, equal by Euclid Chemical Corporation; Master Builders Company or equal.
- B Non-shrink grout shall be Masterflow 713 by Master Builders Company, Euco N-S by Euclid Chemical Co.; Five Star Grout by U.S. Grout Corp. or equal.

PART 3: EXECUTION

3.01 INSTALLATION

- A Assemble and install components of pipe penetration assemblies as detailed on the Drawings.

END OF SECTION

SECTION 01176

MEDIUM VOLTAGE INDUCTION MOTORS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This Section covers the supply and installation of medium voltage induction motors for the Zatory pumping equipment specified in Section 11214.

1.02 SUBMITTALS

- A. Submit descriptive shop drawings including the following:
1. Descriptive information and outline drawings.
 2. Nameplate data in accordance with NEMA MG 1.
 3. Enclosure type, accessories, finish, and handling provisions.
 4. Frame size, dimensions, and motor weight.
 5. Conduit box dimensions and detail drawings showing lightning arresters, surge capacitor, and current transformer mounting.
 6. Bearing type and accessories (RTD's, vibration transducers, etc.).
 7. Bearing lubrication system.
 8. Wiring interconnection diagrams and conduit connection details.
 9. Space heater voltage and watts.
 10. Description and type of motor RTD thermal protection.
 11. Mechanical protective devices and accessories (temperature gauges, manometers, alarm switches, etc).
 12. Description of insulation system.
 13. Motor Weight.
 14. Distance from motor base to center of gravity.
 15. Motor reed critical frequency (RCF).
 16. Moment of inertia of the rotor.
 17. Maximum kVAR capacitance allowed for power factor correction.
 18. Maximum allowable shaft displacement (TIR slow roll).
 19. Maximum anticipated horizontal and axial vibration measured at the upper and lower bearing housings while under test.
- B. Submit performance data including the following:

1. Full load speed, current, and horsepower.
 2. Locked rotor and starting inrush currents at 100 percent voltage.
 3. No load current.
 5. Full load and pull-out torques at rated voltage and frequency.
 6. Service factor.
 7. Motor sound power level.
 8. Maximum brake horsepower allowed by the driven equipment.
 9. Number and frequency of permissible starts per hour from cold condition, and the number of hot starts per hour and during a 24 hour period.
 10. Acceleration time with actual full load.
 11. Speed torque calculations for across the line starting from zero speed to synchronous speed.
 12. Speed, torque, current curves superimposed on load curves.
 13. Motor thermal withstand curves - locked rotor and motor running.
 14. Bearing life calculations, both upper thrust bearing and lower guide bearing.
 15. Induction motor time constants.
- C. Submit quality control, test procedures, and test results including the following:
1. Detailed outline of factory test procedures prior to commencement.
 2. Factory test reports for tests performed on each motor provided.
 3. Field acceptance test reports.
 4. Installation and handling instructions.
 5. Operation and maintenance manual.
 6. Replacement parts booklet.

1.03 REFERENCE STANDARDS

- A. Motors shall be designed, built, and tested in accordance with the latest revision of the following standards:
1. National Electrical Manufacturers Association Inc. (NEMA)
 - a. NEMA MG1 - Motors and Generators.
 - b. NEMA MG2 - Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.

- c. NEMA MG3 - Sound Level Prediction for Installed Rotating Electrical Machines.
 2. National Fire Protection Association (NFPA)
 - a. NFPA-70 - National Electric Code.
 3. Underwriters Laboratories, Inc. (UL)
 - a. UL-1004 - Electric Motors.
 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 - a. IEEE 1 - General Principles for Temperature Limits in the Rating of Electric Equipment.
 - b. IEEE 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - c. IEEE 85 - Test Procedures for Airborne Sound Measurements on Rotating Electric Machinery.
 - d. IEEE 112B - Standard Test Procedure for Polyphase Induction Motors and Generators.
 - e. IEEE 275 - Recommended Practice for Thermal Evaluation of Insulation Systems for AC Electric Machinery Employing Form-wound Pre-insulated Stator Coils, Machines Rated 6,900 V and Below.
 - f. IEEE 429 - Standard Test Procedure for the Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form-wound Stator Coils.
 5. American Bearing Manufacturer's Association Inc. (ABMA)
 - a. ABMA-9 & 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

- A. The motor manufacturer shall maintain a documented ISO 9001 quality assurance program implementing suitable procedures and controls to monitor all aspects of production and testing.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Provide storage and handling per motor manufacturers installation instructions. Do not store motors in areas subject to corrosion or continuous vibration.
- B. Energize motor space heaters to prevent moisture condensation throughout the storage and construction period. When motor is not stored in a dry, indoor, heated location, cover each motor with plastic or similar material and provide heated or circulating air and/or desiccant to protect against moisture condensation.
- C. Maintain the bearings during storage and while idle. For grease lubricated bearings, inject a small quantity of grease into each bearing every three months, inspect purged grease for water or rust, and rotate motor shaft by hand to check for binding. Oil lubricated bearing

housing shall be filled with preservative oil if the storage or idle time will exceed 30 days. Keep a written maintenance log which shall be accessible to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

A. Performance

1. Each motor shall develop ample torque to operate the load throughout its operating speed range at a voltage plus/minus 10 percent nameplate rating. Where required to be operated on a reduced voltage starter, each motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.
2. Each motor shall operate successfully at rated load and rated voltage with plus/minus 5 percent of rated frequency.
3. When operated under the service conditions as specified, motor windings shall be capable of carrying the full rated load continuously in a 40 degrees C ambient without exceeding a Class B temperature rise, or the temperature rise specified. In all cases, the winding insulation shall be fully Class F rated.
4. Each motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.0) service factor, under any condition of mechanical or hydraulic loading.
5. Based on a NEMA standard load inertia, each motor shall be capable of 3 cold and 2 hot starts per hour.
6. Each motor shall be capable of withstanding an overspeed of 125 percent above the rated synchronous RPM.
7. Each motor shall provide minimum performance characteristics for locked rotor torque, pull-in torque and pull-out torque with rated voltage and frequency applied as defined by NEMA MG1,, unless other torque values are specified.
8. The motor shall be duty rated and classified for Extra High Thrust, or High Thrust if coordinating certifications from pump manufacturer and motor manufacturer confirm that High Thrust will meet bearing life requirements and is suitable for this application.

2.02 SPECIFIC DESIGN CRITERIA

A. Environmental Criteria

1. Environment: Water pumping plant.
2. Maximum ambient temperature: 50 degrees C.
3. Altitude: 655m above MSL.
4. Operational humidity: Up to 90 percent non-condensing.
5. Load: Vertical Turbine pumps specified in Section 11214

B. Design Requirements

1. Horsepower: 900 HP

2. RPM: 1500
 3. Operating voltage: 6.6 kV, 3 Phase, 50 Hz.
 4. System configuration: Solidly grounded wye
 5. Service factor: 1.15
 6. Power factor at full load: 91
 7. Power factor at 3/4 load: 90
 8. Inrush limit: Design Code G
 10. Minimum full load efficiency: 96.9 percent
 11. Minimum 3/4 load efficiency: 96.8 percent
 12. Minimum 1/2 load efficiency: 96.2 percent
 13. Temperature rise above specified ambient: 80 degrees C.
 14. Noise level at 1 m: 85 dBA at no load measured from the motor.
 15. Vibration limits: Not to exceed 0.1 inch/sec velocity at rated rpm and 0.2 inch/sec at any frequency, motor shall be mounted on a rigid foundation and vibration readings at any location on motor shall not exceed previous listed values.
- C. Coordinate shaft load WK2 and mounting requirements with the pump manufacturer.

2.03 CONSTRUCTION

A. Stator Construction

1. The stator core shall be built up with high grade, non-aging laminated silicon steel, each lamination core plated to minimize eddy current losses. The laminations shall be adequately keyed or dovetailed to the stator frame and securely held in place at each end. There shall be no perceptible buzzing of laminations during operation. The coil slot wedges shall be of glass reinforced polyester Class F material or equal.
2. The stator winding shall be provided with full Class F insulation or better. A split component epoxy insulation system shall be used in order to provide high resistance to moisture and other contaminants. All windings shall be copper, assembled using form wound coils of the same size and shape. Turn-to-turn insulation shall be provided to ensure machine winding protection against surges at the machine terminals (L-G) of 2X peak rated line-to-line voltage with a rise time of 1.3 micro seconds.
3. Form wound coils shall be constructed in a way and of materials suitable for VPI treatment. Coils shall be made from heavy fused polyester glass fiber film coated insulated rectangular copper conductors. Form wound coils shall be made with a full length Nomex slot wrapper rated 5000 Volts minimum which extends well beyond the stator core iron to reduce the possibility of tracking to ground. Loops shall be made and spread to form coils without damage to the wire or insulation. Application of layer insulation shall be uniformly and tightly applied to eliminate stress points and air voids. The stator core shall be free of sharp edges and de-burred prior to the insertion

of the coils. Insulated coils shall be placed in slots with no damage to the coil insulation. Coils shall tightly fit slots. Coils shall be secured to surge ring or treated rope and laced to one another as necessary to prevent distortion and expansion. Felt blocking shall be placed between coils, top and bottom, to secure the coils. The surge ring and blocking shall be designed and installed in such a manner as to restrain the coils during multiple starting or short circuit conditions. The winding connections and lead connections shall be made by a crimped connection, then silver soldered after thoroughly cleaning the connection. After the connection is complete, it shall be cleaned of all flux. The connection shall then be insulated using materials recommended by the varnish manufacturer and compatible with the VPI process and shall be completely sealed. The connections shall be staggered and separated from the winding by an additional Nomex or felt pad. The lead and winding connections shall be securely blocked and laced such that during repetitive starts the winding shall be held in place. After completion of stator winding and connections, the entire stator shall be given a vacuum-pressure impregnation using a polyester varnish or thermal setting epoxy resin and oven cured. An epoxy overcoat shall then be applied to prevent chemical, caustic, or fungus corrosion. The stator is shall then be oven cured to be positive of a completely sealed total insulation system.

4. Motor leads shall have the same insulation class as the windings. Motor lead wire shall be rated 125 C and shall be sized for 105 C at the motor nameplate amperes at 1.0 Sf per EASA recommendations. Leads are to be numbered for clockwise rotation when facing opposite the shaft end.
5. Stators too large for a post-impregnation process may be wound with pre-impregnated and partially cured coils (B-staged), connections made and insulated with mica containing "B" staged epoxy resin, and then cured through a controlled baking cycle.

B. Rotor Construction and Balancing

1. The shaft shall be forged or rolled steel, accurately machined, smoothly finished, with sufficient strength to withstand all stresses resulting from normal operation at any speed up to and including a 25 percent overspeed condition. Provide shaft end details of circular groove and axial keyway to pump manufacturer.
2. The core shall be built up with high grade, non-aging laminated silicon steel, each single piece lamination core plated to minimize eddy current losses. Core mechanical integrity shall not rely on any electrically active component.
3. Rotor bars and end ring shall be copper or a copper alloy with uniform resistance characteristics so as to equalize thermal stresses. The bars shall be rectangular and shall be mechanically locked in the rotor pole slots to minimize movement and vibration. Rotor end rings shall be free of circumferential joints and shall be swaged to the rotor bars by an induction brazing process.
4. Rotors shall be statically and dynamically balanced prior to assembly. Balancing shall be checked after assembly with the motor running at rated speed. Run out on the shaft shall be checked and in no case shall they exceed 0.0015-in measured with a precision indicator with the reading taken near the end of the shaft.

C. Bearings

1. Vertical Bearings
 - a. Vertical motors inherently require a thrust bearing (s) of ample capacity to support the weight of the rotor plus, if specified, the weight of the rotating driven equipment parts and the hydraulic thrust created by the driven equipment. The

size of thrust bearing selected shall be based upon proper engineering practice and shall be an angular contact type, a spherical roller type rated for the duty and thrust requirement specified. The bearing provided shall handle at least 30 seconds of up thrust protection during start up.

- b. Each motor shall be provided with lower guide bearings. The guide bearings must be capable of withstanding all stresses incident to the normal operation of the unit and to the specified overspeed condition.
- c. Both upper and lower bearings shall be oil bath lubricated.
- d. Bearings shall have a minimum 12,000 hours L-10 bearing life for ball and roller bearings as defined in AFBMA 9 and 11.
- e. Bearings shall be manufactured by SKF, Timken, FAG, or Kingsbury.
- f. Provide a velocity type vibration detection system for bearings. The sensors shall be located at the center of the upper thrust bearings and lower bearing.
- g. Oil lubrication bearings shall have a bearing housing of ample size and capacity to provide an adequate supply of oil for self-lubrication. The bearing housing shall be designed to prevent leakage of oil and excessive aeration of the oil. A convenient means for filling and draining the oil reservoir shall be provided. The motor manufacturer shall recommend the correct type, quality and grade lubrication oil required.

D. Frame and Enclosure

1. Motor frames shall be cast iron or welded heavy rolled plate steel, stiff enough to withstand the rotating forces and torques generated and shall be designed to limit or avoid any undesirable harmonic resonances. Provide lifting lugs on motor frame.
2. Motor enclosures shall be designed such that the noise level shall not exceed the sound pressure level specified.
3. The motor enclosure shall be WP-II, designed in accordance with NEMA standards.
4. All machined bolts and screws and other hardware shall be standard UNF/C thread, hex head type and shall be stainless steel. Metric hardware is not allowed.
5. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information listed in NEMA MG1-10.38 or MG1-20.60, as applicable.
6. Inlet air filters on WPI or WP-II enclosures shall be a corrosion resistant, viscous impingement type..

E. Accessories

1. Stator Temperature Sensors: 100 ohm platinum RTD's, two in each phase, six per winding, symmetrically installed between stator coils where highest temperature will occur. One set in each phase to be operational and one set spare. The leads shall be brought out to a separate terminal box on the motor frame. Monitoring shall be in the 6.6 kV motor control center as specified.

2. One temperature sensor per bearing with a spring loaded tip located in the bottom half of the bearing, close to the back of the Babbitt or other approved location. The sensors shall be 100 ohm platinum RTD's. RTD's shall include a conduit connection head with terminal block. All cabling shall be brought out to a common marshalling box serving the entire pumping unit.
3. Space heaters shall be provided to maintain the internal temperature above the ambient when the motor is idle for protection against condensation inside the enclosure. The space heater shall be located in the bottom half of the motor and accessible for inspection. The leads shall be brought out to a separate terminal box. Heaters shall be rated 240 Volts line to neutral, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate.
4. Minimum of two copper faced grounding pads on motor frame.
5. Oversize fabricated steel main terminal box large enough for stress cone terminations, complete with lightning arresters, a three phase surge capacitor and three differential current transformers. Cover shall be bolted and gasketed with handles.
6. Provide a compression type grounding lug, the same size as motor leads, mounted in the conduit box by drilling and tapping into the motor frame or by a double ended silicon bronze cap screw.
7. Separate cast iron motor mounted terminal boxes shall be provided for RTD's and bearing temperature sensors, space heaters, and any other accessories specified. Box shall be rotatable 360 in 90 increments.
8. Acoustical attenuation to limit the Sound Pressure Level to 85 dBA at 1 meter.
9. Non-reverse ratchet. Form sprague clutch type not acceptable.
10. Extra High thrust motor nameplates to also display NEMA nominal efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

F. Power Factor Correction Capacitors

1. Provide heavy duty, industrial type power factor correction capacitors (PFCC) rated for use on a 6.6 kV power supply. The PFCCs are to be selected, recommended and furnished by the motor manufacturer to raise the motor power factor to approximately 95 percent. The capacitor shall be mounted on the equipment base plate adjacent to the motor junction box.
2. Capacitors shall be insulated type and hermetically sealed in painted steel enclosures.
3. Each Capacitor unit shall be furnished with three high interrupting capacity current limiting fuses. Fuses shall be equipped with "blown-fuse" indicators.
4. Capacitor enclosures shall be suitable for conduit connection. Covers shall be gasketed, bolt-on type.
5. Capacitors shall be UL Listed.
6. Capacitors shall be as manufactured by Trans-Coil (TCI); ASEA Brown Boveri; Myron Zucker, or equal.

2.04 SURFACE PREPARATION AND SHOP COATINGS

A. External Surfaces

1. Parts shall be primed with a corrosion inhibiting oxide primer. All external surfaces on assembled motors shall be cleaned; free of grease, oil, dirt, or other contaminants, then coated with a epoxy polyamide (or equivalent) semi-gloss coating that is chemical, solvent, salt water, and acid resistant. Total dry film thickness shall be 4 to 5 mils.

B. Internal Surfaces

1. Internal surfaces, shaft, rotor, end bells and parts shall be covered with a corrosion resistant coating of epoxy paint or equal material of 2 mils minimum dry film thickness for increased life against adverse environmental conditions. The stator bore and end turns shall be coated with clear epoxy varnish in addition to the insulating varnish treatment.
2. Shaft extension shall be protected with a rust preventive strippable coating capable of being peeled off or unwrapped.
3. Machined joints and threaded parts shall be coated with rust inhibiting compound.

2.05 FACTORY TESTING

- A. Each motor shall be given a routine (short commercial) test per NEMA and ANSI standards to determine that it is free from mechanical and electrical defects. Tests shall be performed in accordance with IEEE 112B, consisting of the following:

1. Winding resistance
2. Polarity of field coils
3. High-potential test on field and armature
4. Measurement of air gap
5. Current balance at no load
6. Check no-load field current at normal voltage and frequency

- B. Additional testing shall be performed in accordance with IEEE 112, consisting of the following:

1. Tests to establish motor efficiencies, including the determination of I-R losses, core losses, friction and windage losses, and stray load losses in accordance with testing methods prescribed by IEEE 112 - Method B.
2. Tests to establish temperature rise, including open and short circuit heat runs in accordance with testing methods prescribed by IEEE 112.
3. Tests to establish starting characteristics, including starting and accelerating torque and current by the reduced voltage, method in accordance with IEEE 112.
4. Noise test in accordance with IEEE 85. Octave band sound pressure level shall be measured in a hemispherical array enclosing the motor, the sound power level determined and then the mean sound pressure level at 1 meter (3 feet) from the major

machine surfaces calculated. The motor shall be operating during test at no-load with rated voltage and frequency applied.

5. Stator sealed insulation acceptance test in accordance with ANSI C50.26 (IEEE 429-Section 4).
6. Measurement of vibration. Vibration is not to exceed 0.1-in/sec velocity at rated rpm and 0.2-in/sec at any frequency. Motor shall be mounted on rigid foundation and vibration readings at any location on motor shall not exceed previous listed values.

C. Test Reports and Documentation

1. Test reports
 - a. Document all testing procedures and results In accordance with ANSI and NEMA standards.
 - b. Submit copies of the complete certified test reports to the Owner within 30 days after the completed test.
2. The following curves shall be furnished for each motor. Curves shall be plotted at 100 and 80 percent voltage:
 - a. Speed-Torque-Amps curve.
 - b. Acceleration Time vs Amps curve.
 - c. Safe Stall Time curve.
 - d. Vibration (balance) reference B.6 this section.

D. Witness Test and Inspection

1. The factory testing will be witnessed by the Owner or its designated representative.
2. Waiving of the Owner's right to witness inspection and testing of the equipment shall in no way relieve the manufacturer of the responsibility of performing the specified tests or furnishing equipment in accordance with this specification.
3. Notify the Owner in writing at least 21 days in advance of scheduled factory testing of each motor or retesting of the motor(s).
4. In the event a motor retest is required, the Contractor shall provide air transportation to and from the place of manufacture, lodging, meals and pay for labor for the Owner or its representative to witness the factory test.

2.06 Spare Parts

A. Bearings

1. Provide one spare complete thrust bearing (s).
2. Provide one spare complete steady (lower) bearing(s).

B. Packaging Spare Parts

1. Spare parts shall be packaged for long term storage with corrosion protection means

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install the motors per manufacturer's installation instructions.
- B. Visual and Mechanical Inspection
 - 1. Inspect for physical damage.
 - 2. Compare equipment nameplate information with site conditions and report any discrepancies.
 - 3. Inspect for proper mounting, grounding, and connections. Check all hardware for looseness and re-tighten as necessary.
 - 4. Inspect bearings for proper lubrication and rotate motor shaft by hand to check for binding. Oil lubricated bearing housings that have been filled with preservative oil shall be drained and re-filled with the proper grade of bearing oil before putting the machine into service.
- C. Field Commissioning
 - 1. Perform insulation resistance tests in accordance with manufacturer's instructions. If the test fails consult the manufacturer and dry out the machine.
 - 2. Perform a phase rotation test to ensure proper shaft direction with load uncoupled.
 - 3. Check all connections with wiring diagrams prior to energizing. Check for correct CT polarities.
 - 4. Inspect for unusual mechanical or electrical noise or signs of overheating during initial test run.
 - 5. Measure running current and evaluate relative to load conditions and nameplate full load amperes.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1: GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

- A This Section specifies the general methods and requirements of submissions applicable to the following work-related submittals: Shop Drawings, Product Data, Samples, Construction Photographs, Construction or Submittal Schedules. Detailed submittal requirements are specified in the technical specification sections.
- B All submittals shall be clearly identified by reference to Specification Section, Paragraph, Drawing No., or Detail as applicable. Submittals shall be clear and legible and of sufficient size for coherent presentation of data.
- C In order to promote the efficient use of electronic communication, the Contractor shall be capable of updating via e-mail, LAN, WAN or Internet an electronic database log of all submittals, transmittals, correspondence, requests for information (RFIs), meeting minutes, issues and drawing logs using a project management and control software packages such as Meridian. Project systems prolog manager or approved equal, that will be provided to and maintained by the Engineer.

1.02 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

A Shop Drawings

1. Shop drawings, as defined in the General Conditions, and as specified in individual work Sections include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shopwork manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the Work.
2. All shop drawings submitted by subcontractors for approval shall be sent directly to the Contractor for checking. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in delivery of materials.
3. The Contractor shall check all subcontractor's shop drawings regarding measurements, size of members, materials, and details to satisfy themselves that they conform to the intent of the Drawings and Specifications. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractors for correction before submission thereof.
4. All details on shop drawings submitted for approval shall show clearly the relation of the various parts to the main members and lines of the structure, and where correct

fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted for approval.

5. Submittals for equipment specified under various Divisions contained herein shall include a listing of all installations where identical or similar equipment has been installed and been in operation for a period of at least five years.

B Product Data

1. Product data as specified in individual Sections, include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the manufacturer's product specification and installation instructions, availability of colors and patterns, manufacturer's printed statements of compliances and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing and printed product warranties, as applicable to the Work.

C Samples

1. Samples specified in individual Sections, include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols and units of work to be used by the Engineer or Owner for independent inspection and testing, as applicable to the Work.

1.03 CONTRACTOR'S RESPONSIBILITIES

- A Contractor shall insure that he has site staff trained in the use of electronic communications and the approved software.
- B The Contractor shall review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:
 1. Field measurements
 2. Field construction criteria
 3. Catalog numbers and similar data
 4. Conformance with the Specifications
- C Each shop drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and personally signed by the person who actually performed the review of the Contractor:
"Certification Statement: By this submittal, I hereby represent that I have determined and

verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." Shop drawings and product data sheets A3 and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to the Engineer's Representative a copy of each submittal transmittal sheet for shop drawings, product data and samples at the time of submittal of said drawings, product data and samples to the Engineer.

- D Notify the Engineer in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.
- E The review and approval of shop drawings, samples or product data by the Engineer shall not relieve the Contractor from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will have no responsibility thereof.
- F No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The Owner will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
- H Project work, materials, fabrication, and installation shall conform with approved shop drawings, applicable samples, and product data.

1.04 SUBMISSION REQUIREMENTS

- A Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other contractor.
- B Each submittal, appropriately coded, will be returned within [30] calendar days following receipt of submittal by the Engineer.
- C Number of submittals required:
 - 1. Shop Drawings as defined in Paragraph 1.02 A: Five copies.
 - 2. Product Data as defined in Paragraph 1.02 B: Five copies.
 - 3. Samples: Submit three (3) samples or the number stated in the respective Specification Sections.
- D Submittals shall contain:
 - 1. The date of submission and the dates of any previous submissions.

2. The Project title and number.
3. Contractor identification.
4. The names of:
 - a. Contractor
 - b. Supplier
 - c. Manufacturer
5. Identification of the product, with the specification section number, page and paragraph(s).
6. Field dimensions, clearly identified as such.
7. Relation to adjacent or critical features of the Work or materials.
8. Applicable standards, such as ASTM, Federal, ISO, B.S. or JSS Specification numbers.
9. Highlighted identification of deviations from Contract Documents.
10. Highlighted identification of revisions on resubmittals.
11. A blank space suitably sized for Contractor and Engineer stamps.

D. Submittal Completeness

1. The Contractor shall provide complete submittal data for all components of a unit or system at one time so that the Engineer can see the entire unit/system at one time, not as the separate individual components. This is important in order for the Engineer to determine if the entire unit/system will perform as intended.

1.05 REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES

- A The review of shop drawings, data, and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed:
1. as permitting any departure from the Contract requirements;
 2. as relieving the Contractor of responsibility for any errors, including details, dimensions, and materials;
 3. as approving departures from details furnished by the Engineer, except as otherwise provided herein.

- B The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.
- C If the shop drawings, data or samples as submitted describe variations and show a departure from the Contract requirements which Engineer finds to be in the interest of the Owner and to be so minor as not to involve a change in Contract Price or time for performance, the Engineer may return the reviewed drawings without noting an exception.
- D Submittals will be returned to the Contractor under one of the following codes.

- Code 1 - "APPROVED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.
- Code 2 - "APPROVED AS NOTED". This code is assigned when a confirmation of the notations and comments **IS NOT** required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.
- Code 3 - "APPROVED AS NOTED/CONFIRM". This combination of codes is assigned when a confirmation of the notations and comments **IS** required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 7 Calendar Days of the date of the Engineer's transmittal requiring the confirmation.
- Code 4 - "APPROVED AS NOTED/RESUBMIT". This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 15 Calendar Days of the date of the Engineer's transmittal requiring the resubmittal.
- Code 5 - "NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

- Code 6 - "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.
- Code 7 - "RECEIPT ACKNOWLEDGED" - This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's review and approval; and, is being filed for informational purposes only. This code is generally used in acknowledging receipt of *means and methods of construction* work plan, field conformance test reports, and Health and Safety plans.

Codes 1 through 5 designate the status of the reviewed submittal, with Code 6 showing there has been an attachment of additional data. Code 7 is used as may be necessary.

- E Resubmittals will be handled in the same manner as first submittal. The same number of submittal copies, five, will be required for all resubmittals. On resubmittals the Contractor shall direct specific attention, in writing on the letter of transmittal and on resubmitted shop drawings by use of revision triangles, highlighting or other similar methods, to revisions other than the corrections requested by the Engineer, on previous submissions. Any such revisions which are not clearly identified shall be made at the risk of the Contractor. The Contractor shall make corrections to any work done because of this type revision that is not in accordance to the Contract Documents as may be required by the Engineer.
- F Partial submittals may not be reviewed. The Engineer will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor, and will be considered "Not Approved" until resubmitted. The Engineer may at his option provide a list or mark the submittal directing the Contractor to the areas that are incomplete.
- G Repetitive Review
1. Shop drawings and other submittals will be reviewed no more than twice at the Owner's expense. All subsequent reviews will be performed at times convenient to the Engineer and at the Contractor's expense, based on the Engineer's then prevailing rates. The Contractor shall reimburse the Owner for all such fees invoiced to the Owner by the Engineer for subsequent reviews as stated above. Submittals are required until approved.
 2. Any need for resubmissions, or any delay in the Engineer's review of submittals, will not entitle Contractor to extension of the Contract Time.
- H If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof to the Engineer at least seven working days prior to release for manufacture.
- I When the shop drawings have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the Engineer.

1.06 DISTRIBUTION

- A Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the Engineer. Number of copies shall be as directed by the Engineer, but shall not exceed 6.

1.07 CONSTRUCTION PHOTOGRAPHS

- A The Contractor shall have an average of 12 color photographs per month made of the work during its progress and 12 color photographs each of the original and completed facilities. The photographs shall be of such views and taken at such times as the Engineer directs.
- B All photographic work shall be done by a qualified person acceptable to the Engineer. Three ordinary size prints of each photograph shall be furnished promptly to the Engineer, and each print shall have a glossy finish and be mounted in plastic sleeving on a substantial backing. Selected (not more than 3 per month) photographs shall be enlarged to A4 size.
- C The film negatives shall be turned over to the Engineer.
- D Each enlarged photograph shall have a label, approximately 50 mm wide by 40 mm high containing thereon in neat lettering:
 1. Contractor's name and Project Identification
 2. Short Description of View
 3. Photo No. and Date Taken.

1.08 CONSTRUCTION SCHEDULE

- A General: The Contractor shall, within the periods indicated in the General Conditions, submit for the approval of the Engineer a program of the Work indicating the phases and extent of work to be carried out. The Employer and the Engineer shall have, at any time, the full authority to request any modifications to such program whether before or after approval of such program and the Contractor shall abide by such requests and revise the program accordingly at no additional cost to the Employer.
- B Critical Path Schedule: The Contractor shall prepare his program for the Works upon an approved system of Critical Path Analysis facilitating the accurate planning of the Contract in the form of "Time Resources" and "Cost Controls" so as to ensure accurate forward planning and coordination of the Contractor's activities with those of the Employer and others in connection with the Project or ongoing activities and services and provide cash flow forecast. The Contractor shall use a computer software for scheduling and project management program such as Microsoft Project or approved equal. The use of spread-sheet programs shall not be acceptable.

The Schedule shall include as a minimum, the earliest starting, earliest finish, latest starting, latest finish dates, and the total float for each task or item. The Schedule shall account for all Work in addition to the work of the subcontractors. In addition to all reasonably important construction activities, the Schedule shall provide for the proper sequence of construction considering the various crafts, purchasing time, submittal approval, material delivery,

equipment fabrication, vacations and holiday, and similar time consuming factors, including reasonable assumptions for customs clearance.

- C Preliminary Network: Within fourteen (14) days of the Award of Contract, the Contractor shall submit for the approval of the Engineer details of his proposed program and "Preliminary Network Diagram" in hard copy and electronic format.

This network shall contain the Contractor's proposed detailed program together with full supporting Planning Data for the Construction and Completion of the Works and/or any section thereof by not later than the prescribed times for completion.

- D Final Approval: The final program of Works and Detailed Network Diagram will be approved within fifteen (15) days of the date of receipt of same in an acceptable form by the Engineer and will be signed and dated by the Engineer and the Contractor.
- E Copies to be Provided: After approval and signing by the Engineer the Contractor shall supply to the Engineer within seven (7) days of the receipt by the Contractor of the Engineer's approval, five (5) copies of the signed and dated Program and Detailed Network together with one reproducible negative of each document, and the electronic file containing the full schedule. The electronic version shall be generated using Microsoft Project 98, latest version equal, as approved by the Engineer.
- F Progress Reporting: With immediate effect from the date of approval, the Contractor shall submit in triplicate to the Engineer, and in electronic format, within the first seven (7) days of each month, an updated schedule showing actual progress by identifying activities commenced and those completed during the previous month, the estimated time required to complete all activities under way in relation to the original forecast and the changes in the "Critical Paths" and any suspected interference and method of their elimination, if any. The design of the aforesaid reports shall be as required by and to the satisfaction of the Engineer.
- G Failure to Adhere to Program: The Contractor shall be deemed to be responsible for the progress of the Works, their coordination and non-interference with ongoing activities and those by others. In the event of failure to adhere to the program, the Contractor shall notify the Engineer, without delay, indicating and adopting whatever reasonable means and methods as necessary to ensure adherence to the Contract times for completion, without inducing or giving rise to avoidable interference. Such actions shall be reported in the form of revised Network Diagrams submitted to the Engineer for approval, in hard copy and Electronic Format
- H Revisions to the Schedule: Revised and up-dated Schedule shall be furnished by the Contractor within seven (7) days from the date of the instructions from the Engineer for same. All such revisions shall be accompanied by detailed explanations of and reasons for changes. In addition, minor as well as major network revisions including those activities necessary to clearly show critical areas shall be submitted. Any revisions affecting network logic or the Critical Path shall be subject to approval. Revisions shall be submitted in hard copy and electronic format.

END OF SECTION

SECTION 01410

TESTING AND TESTING LABORATORY SERVICES

PART 1: GENERAL

1.01 REQUIREMENTS INCLUDED

- A Contractor will employ and pay for the services of an Independent Testing Laboratory acceptable to the Engineer and Employer to perform testing specifically indicated on the Contract Documents. Employer may at any other time elect to have materials and equipment tested at a laboratory of the Employer's choice for conformity with the Contract Documents at the Employer's cost. If the Employer's laboratory test results do not generally conform to the Contractor's test results the Contractor shall be responsible for payment to the Employer's testing laboratory.
1. Contractor shall coordinate with the laboratory together with Engineer's Representative to facilitate the execution of its required testing services.
 2. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the Work of the Contract.

1.02 RELATED REQUIREMENTS

- A Conditions of the Contract: Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities.
- B Respective sections of specifications: Certification of products.
- C Each specification section listed: Laboratory tests required and standards for testing.
- D Testing Laboratory inspection, sampling and testing is required for, but not limited to, the following:
1. Site Preparation is included in Section 02100.
 2. Earthwork for Structures is included in Section 02200.
 3. Trenching, Backfilling and Compaction is included in Section 02222.
 4. Pavement Repair and Resurfacing is included in Section 02575.
 5. Buried pipe work is included in Division 2.
 6. Concrete and Concrete Reinforcement is included in Division 3.

1.03 SUBMITTAL

- A Submit to the Engineer the following information regarding the Independent Testing Laboratory.
1. Qualification of Independent Testing Laboratory included: number of years the laboratory has been in business, similar projects the laboratory has undertaken, verification of laboratory equipment to perform laboratory testing required by this project, and verification of field equipment to perform field testing required by this project.
 2. Qualifications of Project Manager and key staff whom will be responsible for the testing program.

1.04 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

- A Laboratory is not authorized to:
1. Release, revoke, alter or enlarge on requirements of Contract Documents.
 2. Approve or accept any portion of the Work.
 3. Perform any duties of the Contractor.

1.05 CONTRACTOR'S RESPONSIBILITIES

- A Assure the prompt services of the testing laboratory to perform the specified inspections, sampling and testing of materials. Promptly notify the Engineer of all irregularities or deficiencies in the Work which are observed during the performance of the specified testing. The Engineer shall have the option to witness all testing. Submit to the Engineer, five copies of all certified test reports prepared by the independent testing laboratory. Include in each report:
1. Date issued.
 2. Contract title and number
 3. Testing laboratory name and address.
 4. Name and signature of Inspector.
 5. Date of inspection or sampling.
 6. Record of temperature and weather.
 7. Date of test.

8. Identification of product and specification section.
9. Location of sample.
10. Type of inspection or test.
11. Observations regarding compliance with Contract Documents.

B Materials and equipment used in the performance of work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. Standard specifications for quality and workmanship are indicated in the Contract Documents. The Engineer may require the Contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and workmanship indicated in the Contract Documents. All costs of this testing and providing statements and certificates shall be a subsidiary obligation of the Contractor, and no extra charge to the Owner shall be allowed on account of such testing and certification.

1.06 INSPECTION

- A Inspection of all materials and equipment incorporated into the Work will be required. Any delay in the Work or additional cost occasioned by the failure of such material or equipment to meet the specifications shall be the Contractor's responsibility.
- B Authorized representatives: the Employer and the Engineer shall have access to the Work wherever it is in preparation or progress. Provide proper facilities for such access and inspection.
- C Contractor shall furnish incidental labor and facilities:
1. To obtain and handle samples at the Project site or at the source of the product to be tested.
 2. For storage of test samples.

END OF SECTION

SECTION 01500

CONTRACTOR'S TEMPORARY FACILITIES

PART 1: GENERAL

1.01 Contractor's Office

- A The Contractor shall maintain site offices at the Zatory Pump Station Site for the duration of the contract.
- B This office shall be sufficiently staffed to receive correspondence from the Engineer during normal working hours.

1.02 TEMPORARY LIGHT AND POWER

- A Contractor shall furnish temporary light and power, for completion of their work with sufficient power capacity to meet the reasonable needs of all subcontractors. Make all their necessary arrangements with the Jordan Electric Authority for temporary electric service, and pay all expenses in connection therewith.
- B All extension cords used shall be properly grounded. Use "hard-service" cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if more than one length is required.
- C Provide general service incandescent lamps as required for adequate illumination. Provide guard cages or tempered glass enclosures, where exposed to breakage. Provide exterior fixtures where exposed to moisture.

1.03 TEMPORARY HEAT

Provide all heat as may be necessary for proper execution, protection, and drying out of the Work.

1.04 WEATHER PROTECTION

Contractor shall furnish, install and maintain temporary heat and enclosures to provide comfortable working areas for personnel during the months of November through March.

1.05 TEMPORARY AIR AND WATER

The Contractor shall provide all air and water, including temporary piping and appurtenances required thereof, as may be required for the cleaning and testing of pipelines and equipment necessary for the Works. Temporary piping and appurtenances shall be removed upon approval of equipment being tested.

1.06 TEMPORARY SANITARY FACILITIES

The Contractor shall provide sanitary, water-flushed toilet units with hand washing faucet/sink facilities fully screened, properly vented and fully enclosed in an approved lockable non-absorbent shell.

1.07 FIRE EXTINGUISHERS

Provide portable UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide portable UL-rated Class ABC dry chemical extinguishers or a combination of NFPA recommended Classes for the exposure. Comply with NFPA 10 and 241 for classification, extinguishing agent and size required by location and class of fire exposure.

1.08 PROJECT SIGN

Furnish and install the project sign as specified in [Section 01580](#). The sign shall be placed as directed by the Engineer and shall remain in position for the life of the construction period.

1.09 STORAGE FACILITIES

The Contractor shall either erect and maintain a storage facility within the limits of the Site or secure other nearby storage facilities acceptable to the Engineer.

Prior to mobilization, the Contractor shall submit for the Engineer's review and approval complete details of the type and location of temporary storage facility proposed.

The facility, whether on or offsite, shall be secure from theft and pilferage and be well protected from moisture and deterioration.

1.10 DAMAGE TO EXISTING PROPERTY

The Contractor will be held responsible for any damage to existing structures, work, materials, or equipment because of his operations and shall repair or replace any damaged structures, work, materials, or equipment to the satisfaction of the Engineer and at no additional cost to the Employer.

The Contractor shall protect all existing structures and property from damage and shall provide bracing, shoring, or other work necessary for such protection.

The Contractor shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by construction transport conveying equipment, materials, or men to or from the work. The Contractor shall make satisfactory and acceptable arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

1.11 SECURITY

The Contractor shall be responsible for protection of the site, and all work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.

1.12 ACCESS ROADS

The Contractor shall establish and maintain temporary access roads to various parts of the site as required to complete the Project. Such roads shall be available for the use of all others performing work or furnishing services in connection with the Project.

END OF SECTION

SECTION 01501

ENGINEER'S TEMPORARY FACILITIES

PART 1: GENERAL

1.01 TEMPORARY OFFICES

- A Temporary offices for the Contractor per Section 01500 shall be established on the job site where approved or directed by the Engineer, adequately furnished, and maintained in a clean, orderly condition by the Contractor. The Contractor or his authorized representative shall be present in the field office at all times while work is in progress. Instructions received there from the Engineer at the field office shall be considered as delivered to the Contractor.
- B Contractor shall provide either a separate building or a partitioned-off space of at least 190 square meters of floor space, independent of Contractor's building for the exclusive use of the Engineer throughout the period of construction. The temporary office shall be weather-tight, have a tight floor at least 20 cm off the ground and shall be insulated all around with rigid insulation board not less than 12 mm thick and suitably ventilated. The office shall have at least three screened windows capable of being opened, a screen door and a solid door provided with cylinder lock and three keys. The office shall be provided with janitor service, heating equipment, electrical wiring, outlets and fixtures suitable to light the tables and desk adequately as directed. Provide separate toilet facilities for the exclusive use of the Engineer..
- C The office shall have the following furniture and equipment:
1. One plan table, 0.9 m x 1.8 m and one stool
 2. Ten Desks about 0.75 m x 1.65 m with desk chairs with casters
 3. Ten additional desk side chairs
 4. Vertical Plan rack, as directed
 5. 12 Shelf Book Case (1.2 m wide) as directed
 6. Ten 4-drawer, legal size metal filing cabinets with lock
 7. Coat rack and hooks
 8. Air Conditioners sized adequately for the office size
 9. One A3/A4 Size Auto-feed Duplicating (Photocopying) machine with paper and toner. The photocopying machine shall be as manufactured by Xerox, or approved equal. The Contractor shall provide all paper, ink, and toner for photocopying for the duration of the contract.

10. One conference table 2.5 m long, and three small meeting tables..
11. 21 static chairs, and twenty-five swivel chairs.
12. First aid kit suitable for 12 people with instruction manual, similar to American White Cross No. K10 or approved equal.
13. Twelve (12) plastic safety helmets, confirming to ASTM 01 ISO Standards.
14. Two battery powered(D size, 1.5 V) flash lights.
15. Computers, Printers and Software:
 - a. 6 Desk top computers and 3 laptops, each IBM compatible Pentium computers each meeting the following requirements:

Desk top specs should be as follows:

1. Intel® Pentium® 4 with HT and XD technology,(3.20 GHz, 1 MB L2 Cache).
2. Intel's Next Generation 945GV Express chipset
3. 800MHz
4. 512MB DDR2 RAM 400MHz expandable to 2GB.
5. Cache per processor 1MB Cache
6. Integrated Intel® Graphics Media Accelerator 950 with up to 224MB shared memory.
7. Integrated Broadcom 5751 Gigabit Ethernet LAN solution 10/100/1000² Ethernet Remote Wake Up and PXE support.
8. 48X CD-ROM Drive
9. 80GB (7200rpm) SATA Hard Disk Drive with the latest in S.M.A.R.T technology (ATA6.0).
10. Standard 3.5" 1.44MB diskette drive
11. Minitower (MT) Chassis: Two internal 3.5" hard drives; One external 3.5"; Two external 5.25"
12. Two full height PCI, One PCIe x1 full height
13. Eight (8) Universal Serial Bus (USB) , One (1) High speed serial port, One (1) enhanced parallel port, One (1) RJ-45 ports, Microphone, stereo in, stereo out (back) & stereo out (front), headphone.
14. Original Optical Scroll mouse and Pad
15. Original Enhanced Arabic/Latin keyboard with 104 Keys (A/L imprinted)
16. Altec Lansing ADA-215 Speakers
17. 17 Inch LCD Monitor
18. Mini-Tower (41.14cm x 18.96cm x 43.18cm)
19. 230W Universal Power Supply with MK Power Cables. 200-250V
20. All necessary drivers for HDD, CD-Rom, Audio, NIC, and Ethernet adapter, etc are delivered with the system

21. Standards: CIM, Desktop Management Interface (DMI) 2.0s (optional), WBEM, Wired for Management (WfM) 2.0, SNMP (optional), SM BIOS 2.3, DDC2b; multiple remote-boot protocol supported
22. Windows XP Professional
23. Latest Microsoft office Professional.
24. Virus Protection Software - McAfee enterprise with updates during the project duration
The version of the Software provided shall be the latest version at the time the Engineers Facilities are provided. All software shall be licensed to, and provided to, the Engineer when the Computer Equipment is delivered. Original software CDs, diskettes and documentation shall be provided to the Engineer.
25. Computer shall be Dell, IBM, HEWLETT Packard or approved equal.
 - b. One Black and White Printer capable of printing on A3 paper Hewlett Packard HP LaserJet 5000 or approved equal.
 - c. Four un-interruptible Power Supply units sized for the five desktop PCs.
 - d. One A3 color printer with all paper and ink required for the duration of the project. The printer shall be Hewlett Packard Laser, or approved equal.
 - e. One color scanner by Hewlett Packard or approved equal.
 - f. Approved computer hardware and software support shall be provided for the duration of the project. All systems must be installed and configured by the Contractor to the satisfaction of the Engineer. Contractor shall have all computer equipment assembled on site and connected.
16. One 12 cubic foot refrigerator with freezer.
17. One Fire Extinguisher. Fire extinguisher with mounting bracket shall be 10 kg capacity dry chemical type, ULS rated for 20A-80 B:C. Extinguisher shall be red enameled steel cylinder with indicating gauge.
18. One cross-cut shredder with basket, Fellowes Model No. P600C02, or equal.
- D The Contractor shall supply and pay for all fuel for heating and cooking and all electrical bills.
- E The Contractor shall supply and pay for all running water for general use and sanitary fixtures and cold bottled water for drinking. Provide suitable disposable cups, etc.
- F. Digital Camera: Contractor shall provide one new Nikon 3.2 Megapixel 3x optical/4x Digital Zoom digital camera or approved equal for Engineer's use during the project duration. Camera shall include 2-128MB memory cards (or one 256 MB card), rechargeable NiH batteries and charger kit, flash memory reader, USB cables and all necessary software for

download to the site computer. After completion of project the camera will become the property of the Owner.

1.02 TELEPHONE AND INTERNET SERVICE

- A Install two private telephone lines in the field office for the Engineer's exclusive use; one voice grade line with caller ID and call waiting features and a second line for a computer modem. Provide and maintain six suitable push button phone instruments. Pay all bills charged against the telephone, including installation charges and all monthly charges throughout the construction period. Monthly charges to be paid by the Contractor shall not exceed JD 250.
- B Provide in conjunction with the telephone, an automatic telephone answering device to record messages when the office is not manned.
- C Provide in conjunction with the telephone a fax plain paper machine for sending and receiving correspondence. The fax plain paper machine shall be HP Office Jet 7400 All-in-One , or approved equal. The Contractor shall provide all paper and ink for the fax machine for the duration of the contract.
- If the Contractor cannot provide phone service as specified in paragraphs A, B and C above within one month after the Notice to Proceed, he shall provide three mobile phones for the Owner's / Engineer's use at the project site and pay all costs thereof.
- D Provide ADSL internet/e-mail connection services by an approved internet service provider in Jordan for the period of the Contract. Pay all related monthly charges up to a maximum of JD 75 per month in addition to the connection initial costs.
- E Provide Seven mobile telephone with subscription to mobile Telecommunication Company for the duration of the contract. Provide all related monthly charges up to a maximum of JD 50 per telephone per month excluding sign-up and flat fees. Pay all sign-up flat fees.

1.03 Project Vehicles

- A Provide Five (6) project vehicles (two SUVs and Four Pick up Trucks) for the use of the Engineer and allocated as follows: One SUV will be allocated for the WAJ liaison engineer, five vehicles will be allocated for the Engineer's staff. The Contractor shall be responsible for the maintenance of the vehicles and providing all fuel required for project related activities. The vehicles shall be four wheel drive, four door utility/sports vehicles of the following specifications:

SUVs

- Engine: minimum 4 liter gasoline;
- Transmission: 5 speed manual gearbox.

In addition, the vehicles shall be current year's or latest available model at time of purchase with power steering, air conditioning, all terrain tires, power brakes, and radio Am/Fm and cassette.

The SUVs shall be equivalent to Ford Explorer, Chevrolet Blazer, or approved equal.

Pick up Trucks

Vehicle Type:	Pick-up Truck, Light colored
Year:	Latest year made
Drive:	4x4
Cab Size:	Super Cab or equivalent
Equipment:	All standard with folding minors and cup holder
No. Of Passengers:	Five (5) to six (6)
Interior Seating:	Heavy-duty vinyl, but cloth preferred, with head rests, full adjustable
Interior Floor:	Heavy-duty full vinyl covering, with floor mats
Rear Seating:	Fold-up
Seat Belts:	Full automatic, with driver and passenger assistance handles
Sun Visors	Two front and side
Cooling:	Heavy-duty air condition and heat, with defroster
Steering:	Power assisted
Airbags:	Required with passenger disarming function
Step-up:	Running boards
Protection:	Auto-lock and alarm
Instrumentation:	Full panel with gauges, speedometer read in km
Electronics:	AM/FM (export frequency) Cassette Stereo, with digital clock and speakers
Fuel Type:	Diesel
Engine:	V8 Cyl, 6L or equivalent
Transmission:	Five (5) speed automatic, with O-drive and torqshift
Front Suspension:	Heavy Duty
Rear Suspension:	Heavy Duty, Multi-leaf
Brakes (F/R):	Discs - 4-wheel ABS, Power assisted
Fuel Tank Capacity:	Large, with lockable fuel cap
Wheel Base:	137 inch minimum
Electric:	Heavy-duty 12 Volt system including the alternator (130 A minimum), heavy-duty battery (156 Ah minimum),
Tires:	16-inch steel rim, all terrain steel belt radials, with full size spare tire and lockable wheel nuts

B Maintenance by the Contractor at his expense for the above vehicles shall include:

1. All maintenance, repair and lubrication, including all replacement parts and materials shall be included. During periods of maintenance repair or servicing replacement vehicles shall be provided.
2. Fuel shall be provided for all vehicles up to a maximum cost of JD 400 per month per vehicle.
3. All vehicles shall be insured with an approved insurance company to fully

comprehensive standard required by law of the Hashemite Kingdom of Jordan.

1.04 OWNERSHIP OF ENGINEER'S TEMPORARY FACILITIES AFTER COMPLETION OF CONTRACT

After the official completion of the contract the Contractor shall fully service and hand-over ownership and title to the Employer of all commodities specified for the Engineers office excluding the vehicles, the items to be handed over / owned by the Employer include furniture, computers, software, printers, copying machine, telephones etc.

The vehicles shall become the property of the Contractor.

All costs associated with the transfer of ownership shall be paid by the Contractor.

END OF SECTION

SECTION 01515

TRAFFIC CONTROL AND BARRICADING/CHANNELIZATION

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, equipment, materials and all incidentals required to control and maintain traffic safely and efficiently at construction site locations as shown on the Drawings.
- B Abide by the requirements of the traffic and/or police authority.

1.02 RELATED WORK

- A. Roadway pavement is included under Section 02510.
- B. Pavement repair and resurfacing is included under Section 02575.
- C. Trenching, backfilling and compaction included under Section 02222.

1.03 REQUIREMENTS

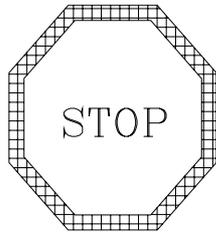
- A At least 15 days before doing any work in any job site, notify said traffic and/or police authority and meet all requirements and conditions necessary.
- B In addition, comply with the following:
 - 1. At all times the main highways shall be open to two-way traffic unless approval to close a lane is obtained from the above mentioned traffic and/or police authority.
 - 2. Make arrangements to the satisfaction of above authorities such that Fridays, holidays, or night-time emergency work can be made immediately when and if necessary while the work is in progress.
 - 3. Do not store any materials on the roadway and shoulders that would interfere with the flow of traffic.
 - 4. Make every effort to accomplish the work as quickly and as efficiently as possible.
 - 5. Steel plates to cover trenches as directed by the Engineer shall be readily available at the site for use where necessary to protect the traveling public.

6. Replace all traffic signs and pavement markings which have been destroyed, disturbed or paved over.

PART II: PRODUCTS

2.01 SIGNS

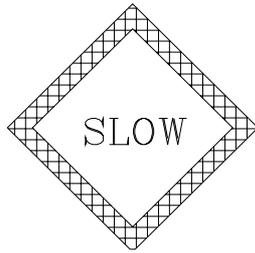
- A Contractor shall provide temporary (portable) traffic control signs in the Arabic and English languages] to alert, advise and guide the traveling motorist and pedestrians of upcoming traffic restrictions.
- B Signs will have a minimum side dimension of 750 mm, mounted so that the lowest part of the sign is 2.0 meter above the ground.



750 mm x 750 mm
black letters, red background



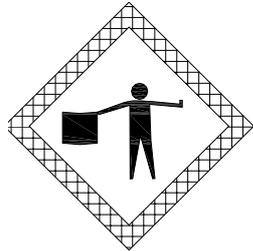
750 mm x 750 mm
black letters, orange background



750 mm x 750 mm
black letters, orange background



750 mm x 750 mm
black letters, orange background



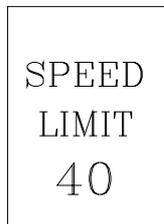
750 mm x 750 mm
black letters, orange background



750 mm x 750 mm
black letters, orange background



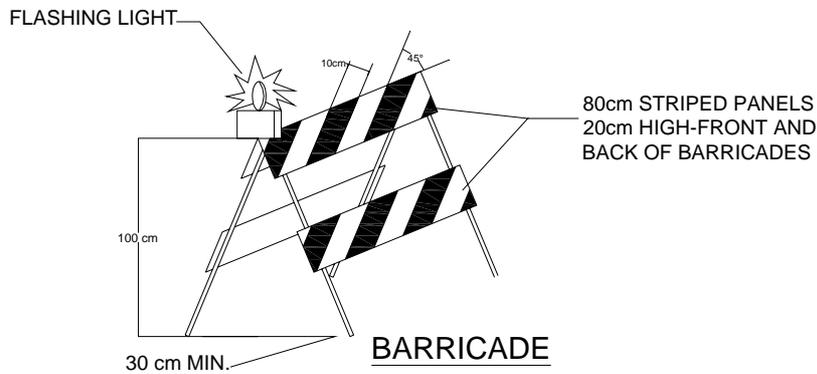
750 mm x 750 mm
black letters, orange background



600 mm x 600 mm
black letters, orange background

2.02 BARRICADES

- A. Contractor shall provide barricades and channelizing devices to protect workmen when working in the street. Barricades and channelizing devices shall be kept clean and fresh appearing at all times.
- B. Markings for barricade panels shall be alternate orange and white stripes (sloping downward at an angle of 45 degrees in the direction traffic is to pass). Both stripes (orange and white) on all barricade panels shall be reflectorized with smooth surface weatherproof reflectorized sheeting.
- C. All barricades shall be constructed of suitable material to the dimensions shown herein. Barricade supports shall be substantial and white in color.



2.03 BARRICADE WARNING LIGHTS

A. The Contractor shall provide barricade warning lights for distant sighting, and marking unexpected hazards in the public right-of-way to alert the motorist that he is traveling in a construction area. They shall be mounted on all barricades, devices during hours of darkness. Barricade warning lights shall be in operation during hours of darkness.

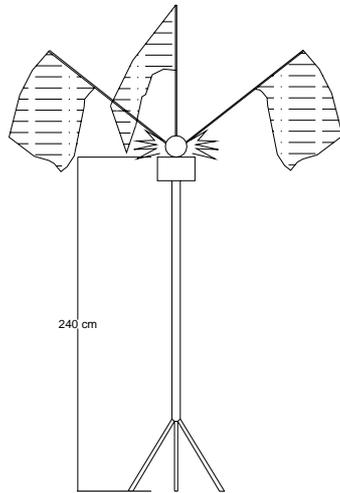
B. Barricade warning lights shall be portable, battery operated, lens directed, and enclosed flashing lights.

C. Barricade warning lights used on signs, barricades and channelizing devices, except high level warning devices, shall be bi-directional. Barricade warning lights used on high level warning devices shall be unidirectional, incorporating the use of a parabolic reflector for increased intensity.

D. Barricade warning light lenses shall have a minimum effective diameter of 175 mm. The color of the light emitted shall be yellow.

2.04 HIGH LEVEL WARNING DEVICES

A. The Contractor shall provide flag type high level warning devices to alert the motorist of an obstruction in the street. These are to be seen over the top of preceding vehicles. Height should be at least 2.4 m above ground to be effective in diverting traffic around obstructions.



HIGH LEVEL
WARNING DEVICE

1. Flag type high level warning devices shall display three flags so that the lowest point of all three flags is 2.4 m or more above the street. The flag shall be 400 mm square or larger. Flags shall be orange or fluorescent red-orange in color. The flag support shall be substantial to resist overturning by wind.
2. During hours of darkness, each flag type high level warning device must be equipped with a minimum of one operating flasher with lens mounted more than 2.4 m above the street.

2.05 CHANNELIZING DEVICES

- A The Contractor shall provide traffic cones for daytime channelization of traffic and to delineate minor construction/maintenance areas. Traffic cones shall only be used during the daylight hours; and, if channelization is needed at night, they should be replaced with vertical panel channelizing device with warning lights.

Traffic cones may be conical or tubular devices generally with square weighted bases. The conical devices shall be a minimum of 0.5 m high. The tubular devices shall be a minimum of 0.7 m high shall be orange or fluorescent red-orange.

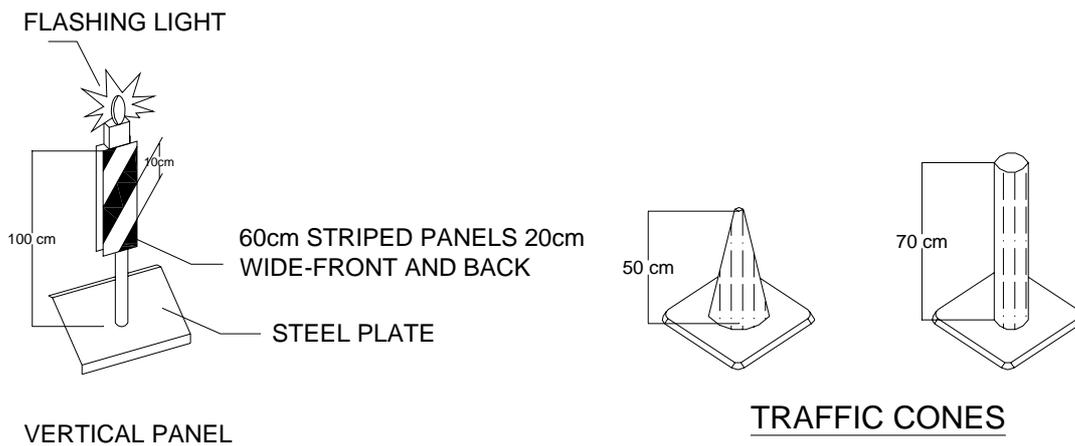
Traffic cones shall be used to channel traffic, divide opposing traffic lanes, and delineate minor construction operations in the street. Cones should be placed in accordance with taper lengths. Spacing of cones shall not exceed 7.5 meters.

- B Vertical Panel Channelizing Devices. The Contractor shall provide vertical panel

channelizing devices for 24-hour channelization, using flashing warning lights mounted at the top.

Markings for all vertical panel channelizing devices shall be alternate 200 mm orange and white strips sloping down at an angle of 45 degrees to the side of which traffic must pass. Vertical panel channelizing devices shall be constructed of suitable material to the dimensions shown. The base and panel support shall be substantial and white in color.

All vertical panel channelizing devices used in the right-of-way during hours of darkness shall have a barricade warning light attached and in operation. The warning light shall be mounted above the marked panel.



CHANNELIZING DEVICES

PART 3: EXECUTION

3.01 FLAGMEN

The Contractor shall provide flagmen at locations where equipment is intermittently blocking or crossing a traffic lane or where only one traffic lane is available for two directions of traffic. Absence of flagmen in critical construction locations is enough reason for the Engineer's Representative to order the Contractor to stop work immediately, cover up open trenches and put the area back to a "safe" motorist and pedestrian environment.

Flagmen shall be trained, alert, courteous, neat and possess a sense of responsibility for the safety of the public and work crew. Flagmen shall wear orange or fluorescent red-orange vests when assisting

with traffic control. The use of orange or fluorescent red-orange hats is desirable.

Flagmen shall use a 600 mm square red or fluorescent red-orange flag on a 1 meter long staff to control traffic.

Flagmen shall be stationed at a readily visible location in advance of the restriction. Flagmen stations shall be marked with a high level warning device. “Flagman Ahead” and “Be Prepared to Stop” signs shall be used in advance of each station.

During hours of darkness, flagman stations shall be illuminated. All traffic control devices shall be reflectorized and have barricade warning lights.

3.02 PEDESTRIAN WALKWAYS

Where deemed necessary by the Engineer, the Contractor shall provide a pedestrian walking area, whether it existed previously or not in active construction areas. It shall be maintained by the Contractor at all times at that active construction site.

All walkways shall be clearly identified, protected from motor vehicle traffic and free of pedestrian hazards (holes, debris, dust, mud, etc.). Pedestrians using temporary walkways shall be protected using traffic control devices, including barricades, cones, signs, etc.

3.03 STREET CLOSURES

The Engineers will not approve a street closure strictly for the convenience of the Contractor. A street closure will be approved only when the Engineer determines it is necessary for the safety of the motorist and pedestrian as well as the Contractor. The procedure for obtaining permission to close a road and to properly sign this road is as follows:

A Permit

A street closure permit shall be submitted for review five working days prior to requested closure date.

B Signing

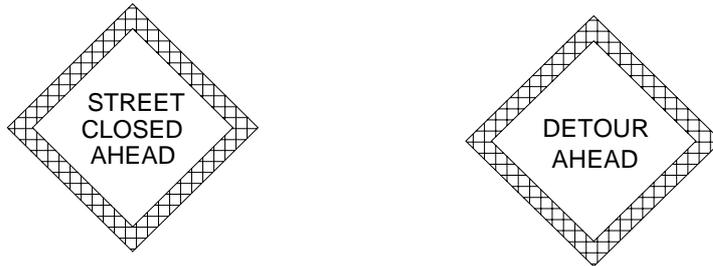
Major Street

The “Street Closed To Thru Traffic” sign shall be used for all complete closures of main streets. When in use, the proper “Detour Arrow” and other detour instructions shall be displayed. “Street Closed Ahead” and “Detour Ahead” signs shall be used in advance of the closure at the following distances.

Speed Zone	“Street Closed Ahead”	“Detour Ahead”
40 KPH	180 m	90 m
75 KPH	300 m	150 m

Local Streets

The “Street Closed” with the “Local Traffic Only” sign installed underneath shall be used. On local street closures, the Engineer requires five days advance notice for review. If the closure is approved, the contractor is required to notify the home owners affected by the closure by mailings, door messages, or in person, of the street closure at least twenty-four hours prior to the closing of the street.



750 mm x 750 mm
Black Letters on orange background

3.04 BARRICADING ILLUSTRATION

The traffic channelization and barricading illustration on the page 12 is presented to show typical application of signs, barricades and channelizing devices.

They illustrate the method for uniform application of standard traffic control devices. Specific situations not illustrated must be applied for by the Contractor and approved by the Engineer.

Barricades or vertical panel channelizing devices shall be used at all times to mark hazards (excavations, holes, equipment, construction materials, piles of dirt, sand, etc.), close streets and to protect workmen in the public right-of-way.

Channelization may include the use of traffic cones during daylight hours. Traffic cones must be replaced with barricades and/or vertical panel channelizing devices during hours of darkness.

All traffic control devices during hours of darkness must be reflectorized and equipped with barricade warning lights. All stripes (orange and white) on all vertical panels shall be reflectorized with smooth surface weatherproof sheeting.

3.05 TRAFFIC CONTROL

Based on the assumption that the pipe line may be installed in the middle third or close to the centerline of the street right-of-way and that one side of the construction (excavation) will be used for construction equipment/plant and the other side would be for motorist and traffic, the following guidelines are given to further discussion, if necessary:

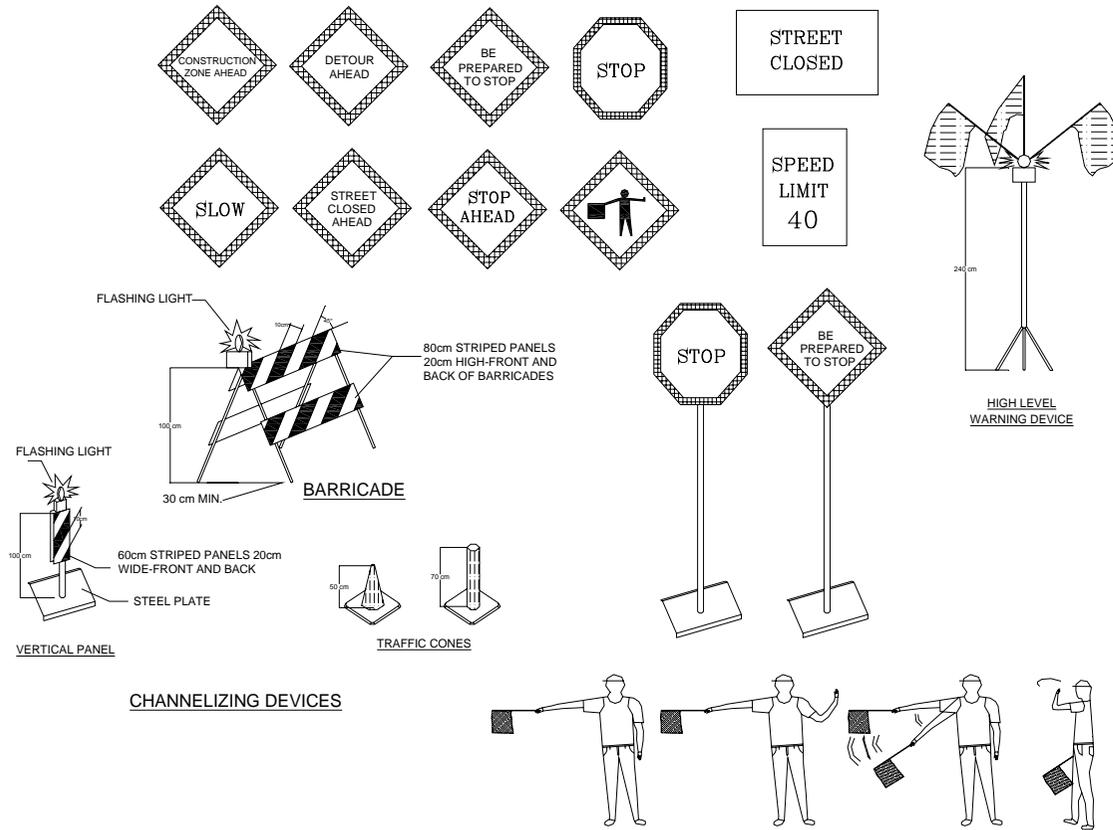
1. For streets with right of way less than

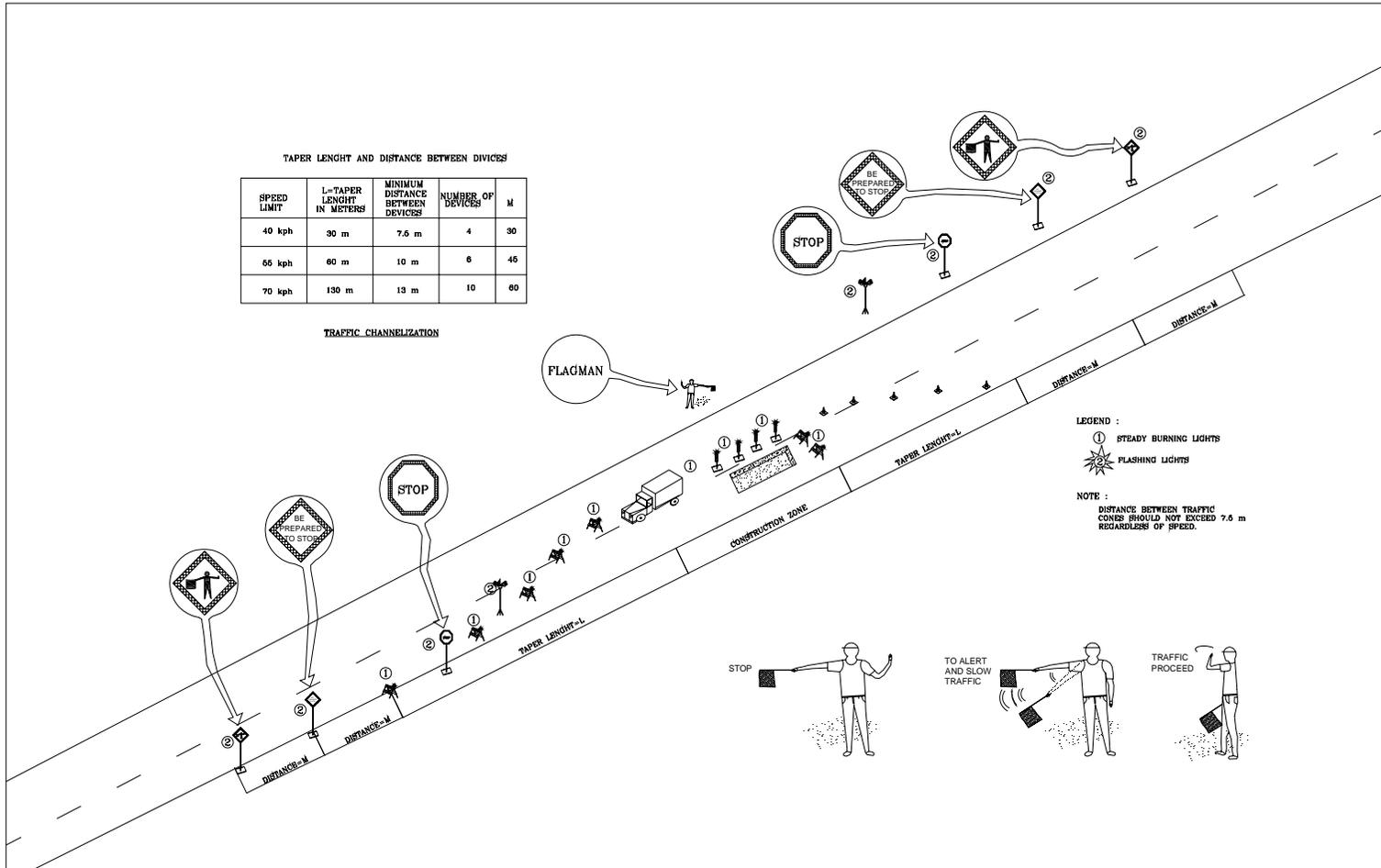
8 meters: STREET CLOSURE WILL PROBABLY BE REQUIRED

2. For streets with right of way:
8 meters to 10 meters:
 - RESTRICTED TRAFFIC
 - ONE LANE Travel with Necessary Barricading and Channelization (with high level warning devices)
 - Minimum of one
 - Flagman to Control Traffic
 - Traffic will have full stop and direction by flagmen at 25 KPH (maximum)

3. For streets with right-of-way
12 meters:
 - Two LANE TRAVEL
 - SLOWED DOWN TO 30 KPH,
 - Traffic Delineated by Traffic channelizing devices and high level warning lights
 - Flagman is optional

4. For streets with right-of-way
14 - 16 metes
 - Same as above except speed can be 40 KPH





END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1: GENERAL

1.01 REQUIREMENTS INCLUDED

- A Furnish, install and maintain project identification signs.
- B Remove signs on completion of construction.

1.02 RELATED REQUIREMENTS

- A Scope of Work is included in Section 01010.

1.03 SUBMITTALS

- A In accordance with the requirements of Section 01300.

1.04 PROJECT IDENTIFICATION SIGNS

- A Two painted signs, of not less than 3 square meters area each, with painted graphic content to include:
 - 1. Title of Project:
NORTHERN GOVERNORATES EASTERN PRIMARY TRANSMISSION
SYSTEM PROJECT
 - 2. WAJ Project No. _____
 - 3. Owner: MINISTRY OF WATER AND IRRIGATION
WATER AUTHORITY and emblem/logo
NORTHERN GOVERNORATES WATER AUTHORITY and
emblem./logo
 - 4. Funding Agency: GOVERNMENT OF JORDAN
UNITED STATES AGENCY FOR
INTERNATIONAL DEVELOPMENT, including logos
 - 5. Engineer: Name, including logos.
 - 6. General Contractor.
- B Graphic design, style of lettering and colors: As approved by the Engineer and subject to the approval of the local authorities and applicable local regulations for signs.

- C Provide a total of 4 project signs, erect one sign at the Pump Station Site, One at the Hofa Reservoir Site and two at a locations to be determined by the Engineer. The signs shall be erected at locations of high public visibility, adjacent to the main entrances to the construction areas, as approved by the Engineer and the Employer.

1.05 INFORMATIONAL SIGNS

- A Painted signs with painted lettering, or standard products.
 - 1. Size of signs and lettering: as required by Engineer.
 - 2. Colors: as required by Engineer, otherwise of uniform colors throughout Project.
- B Erect at appropriate location with bottom of sign approximately 2.2 meters above ground.

1.06 QUALITY ASSURANCE

- A Sign Painter: Professional Experience in type of work required.
- B Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

PART 2: PRODUCTS

2.01 SIGN MATERIALS

- A Structure and Framing: must be new, wood or metal, in sound condition structurally adequate and suitable for specified finish.
- B Sign Surfaces: Exterior superior grade plywood with medium density overlay, standard large sizes to minimize joints.
 - 1. Thickness: Minimum 25 mm or as required to span framing members, to provide even, smooth surface without warping and buckling.
- C Posts shall be pressure treated lumber 100 mm x 100 mm minimum size.
- D Rough Hardware: Galvanized
- E Paint: Exterior (outdoor) quality.
 - 1. Use Engineer-approved colors for graphics.
 - 2. Colors for structure, framing, sign surfaces and graphics: As selected by the Engineer.

PART 3: EXECUTION

3.01 PROJECT IDENTIFICATION SIGN

- A Paint exposed surfaces of supports, framing and surface material; one coat of primer and one coat of exterior paint.
- B Paint graphics in Engineer- approved styles, sizes and colors.

3.02 MAINTENANCE

- A Maintain signs and supports in a neat, clean condition; repair damages to structure, framing or sign.

3.03 REMOVAL

- A Remove signs, framing, supports and foundations at completion of project or when directed by Engineer.

END OF SECTION

SECTION 01601

CONTROL OF MATERIALS

PART 1 GENERAL

1.01 APPROVAL OF MATERIALS

- A. Unless otherwise specified, only new materials and equipment shall be incorporated in the work. All materials and equipment furnished shall be subject to the inspection and approval of the Engineer. No material shall be delivered to the work without prior approval of the Engineer.
- B. Submit to the Engineer, in accordance with Section 01300, data relating to materials and equipment proposed to be furnished for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.
- C. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, submit additional samples or materials for such special tests as may be necessary to demonstrate that they conform to the requirements specified herein. Such samples shall be furnished, stored, packed and shipped as directed at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for the tests.
- D. Any delay of approval resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of a claim against the Owner or the Engineer.
- E. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes and surfaces, provide such samples of workmanship or finish as may be required.
- F. The materials and equipment used on the work shall correspond to the approved samples or other data.

1.02 HANDLING AND STORAGE OF MATERIALS

- A. All materials and equipment to be incorporated in the work shall be handled and stored by the manufacturer, fabricator, supplier and Contractor before, during and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting and any injury, theft or damage of any kind whatsoever to the material or equipment.
- B. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous, reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored

with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking and spalling to a minimum.

- C. All mechanical equipment subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) shall be stored in a building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer.
- D. All materials which, in the opinion of the Engineer, have become so damaged as to be unfit for the use intended or specified shall be promptly removed from the site of the work and no compensation shall be given for the damaged material or its removal.
- E. All pipe and other materials delivered to the job shall be unloaded and placed in a manner which will not hamper the normal operation of the existing plant or interfere with the flow of necessary traffic.

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1. GENERAL

1.01 SCOPE

- A. This section covers Contract closeout requirements in addition to those described in the Conditions of Contract.

PART 2. PRODUCTS (Not Used)

PART 3. EXECUTION

3.01 FINAL INSPECTION OF CONSTRUCTION WORK

- A. When the Contractor considers that all stages of the Works are complete, the Contractor shall make written certification to the Engineer that he has completed the following activities before the Engineer will make a final inspection of this work:
1. Contract Documents have been reviewed.
 2. All stages of the Works have been inspected for compliance with the Contract Documents.
 3. All stages of the Works have been completed in accordance with the Contract Documents.
 4. Equipment and systems have been tested in the presence of the Engineer and are operational.
 5. Performance tests specified in the Contract Documents have been satisfactorily completed.
 6. All stages of the Works are completed and ready for final inspection.
- B. When the construction work is ready for final inspection, the Contractor shall submit the certifications listed in paragraph A above to the Engineer that the Works are ready for final inspection. The Contractor shall notify the Engineer at least 14 days prior to the proposed inspection. The actual date of the completion inspection shall be established by the Engineer. The Contractor, along with the Engineer, shall make a final inspection to verify the status of completion. During the inspection, the Contractor will develop a "punch list" of items that do not conform to the Contract Documents.
- C. If the Engineer determines that the Works are incomplete or defective, the Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work. The Contractor shall then take immediate steps to correct the stated deficiencies and shall send a second written certification to the Engineer when all stages of the construction work are completed. Upon receipt of the second certification, the Engineer shall then re-inspect the Works. After all deficiencies have been corrected, a final inspection of the Works in company

with the Contractor and the Engineer shall be conducted. The actual date of the final completion inspection shall be established by the Engineer.

- D. The Completion inspection and any deficiency corrections required by this paragraph shall be accomplished within the time stated for completion of the entire task or any particular increment thereof.
- E. When the Engineer determines that all stages of the Works are acceptable under the Contract Documents, and the Engineer has received the closeout submittal from the Contractor, the Engineer, with the Employer's approval, shall issue a Certificate of Completion for the Works.
- F. Before the Engineer issues a certificate of Completion for the Works, the Contractor shall submit record documents for the Project which accurately reflect the Works as constructed.

3.02 PROJECT RECORD DOCUMENTS.

- A. Documents Required. The Contractor shall prepare and maintain record documents for the Project which accurately reflect the Works as constructed to facilitate the preparation of record drawings. The Engineer will provide the Contractor with electronic files containing details of all Contract Drawings. The original electronic files and the record drawing electronic files (produced in a format acceptable to the Engineer) are to be submitted to the Engineer on completion. Documents shall be submitted to the Engineer for review prior to issuance of the certificate of partial completion of all construction work.
- B. Documents that shall be maintained at the Works site and submitted to the Engineer include, but are not limited to, the following:
 - 1. Drawings printed on reproducible film "perma-trace" and electronic drawing files on CD in a software program acceptable to the Employer.
- C. Keep on-site two complete full size sets of Contract Drawings on which to record all as-constructed changes from the original Contract Drawings and prepare such additional drawings as are required to provide a complete set of Contract Record Drawings as the Works proceed. The Record Drawings shall be neat and tidy and to a standard equal to the Contract Drawings. The Contractor must employ an experienced draftsman/CADD Operator to make the Record Drawings.
- D. It is important that all as-constructed changes are recorded as the Contract proceeds. The Contractor shall be responsible for the measurement and recording of all changes in a timely manner. The Engineer will review the drawings monthly and no Contractor Pay Requests will be approved for payment until all Record Drawings are current.
- E. Upon completion of the works and after review and approval of the Record Drawings by the Engineer, the Contractor shall submit the final record documents as follows:
 - 1. One transparent copy of all drawings
 - 2. Three blue prints of all drawings
 - 3. One electronic copy, compatible with the Employers' current software, of all drawings on diskettes.

- F. Maintenance of Documents and Samples. The Contractor shall store copies of record documents and samples in the Contractor's field office separate from documents used for construction. The Contractor shall provide files and racks for orderly storage of record documents. The Contractor shall provide a locked cabinet or other secured storage space for samples. The Contractor shall maintain the record documents in a clean, dry, legible condition and shall not use the record documents for general construction inspection purposes. Record documents and samples shall be available at all times for inspection by the Engineer.
- G. Recording. Each document shall be labeled "Project Record" in neat, large colored printed letters. Record documents shall be legibly marked and shall record actual construction conditions, including, but not limited to, the following information:
1. Depths of various elements of foundation in relation to finished first floor datum.
 2. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 3. Location of internal utilities and appurtenances referenced to visible and accessible features of the structure.
 4. Field changes of dimension and detail.
 5. Changes made by field order or Change Order.
 6. Details not on original Contract Documents.
- H. Specifications and Addenda shall be legibly marked and shall include the following information:
1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment installed.
 2. Complete list of subcontractors, manufacturers, and suppliers who furnished labor, materials, or equipment. The address of each firm shall be included together with types of material or work performed.
 3. Changes made by field order or by Change Order.
- I. Document Submittal. Record documents shall be delivered to the Engineer prior to the commissioning (startup) period. All letter-sized material shall be neatly indexed and placed in a two or three ring binder. Drawings shall be bound in sets of convenient size for ease of handling. A transmittal letter, in duplicate, shall accompany the submittal of record documents. The transmittal letter shall contain the following information:
1. Date.
 2. Project title and number.
 3. Contractor's name and address.
 4. Title and number of each record document.
 5. Certification that each record document as submitted is complete and accurate.
 6. Signature of Contractor or his authorized representative.

3.03 CLOSEOUT SUBMITTAL

- A. The Contractor's closeout submittal shall include the project record documents, as specified, and the following certificates and affidavits:
1. Manufacturer's 1 year (minimum) warranties and bonds for all equipment.
 2. Certificates of insurance for products' liability.
 3. Affidavit of payment of all taxes, if required.
 4. Affidavit of Payment of Debts and Claims.
 5. Affidavit of Release of Liens.
 6. Consent of Surety.
 7. Verification of the handing-over of all required Spare Parts.
 8. Submission and approval of all Operation and Maintenance Manuals.
 9. Submission of Equipment Manufacturer's Certificates of Installation Testing and Instruction as specified in Section 01730.

3.04 FINAL PAYMENT

- A. The final account shall be completed prior to final inspection.
- B. Final adjustment of Accounts. The final adjustment to accounts shall be submitted within the period prescribed in the Conditions of Contract, Clause 60, and shall include, but not be limited to, the following information:
1. The original Contract Price, including original authorized cost of the Work and listing of the Provisional Sums.
 2. Additions and deductions resulting from:
 - a. Previous Change Orders.
 - b. Deductions for uncorrected work.
 - c. Deductions for Liquidated Damages, if any.
 - d. Other adjustments.
 3. Total authorized cost of the Works, as adjusted.
 4. Previous payments.
 5. Final payment due.

Upon receipt of the final statement of accounting, the Engineer will prepare a final payment reflecting approved adjustments to the authorized cost of the Works that were not previously made by Change Orders.

3.05 FINAL APPLICATION FOR PAYMENT

- A. The Contractor shall submit the final application for payment in accordance with procedures and requirements stated in the Conditions of Contract.

3.06 PAYMENT

- A. Payment for contract closeout work in this section will not be paid for separately, but will be included as part of the Tender rates.

END OF SECTION

SECTION 01701

PRE-COMMISSIONING OF FACILITIES

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish and pay for all services, reporting, equipment, personnel, water and incidentals required for the testing and pre-commissioning of the new Zatory Pump Station, the Zatory-Hofa pipeline, and all other elements of the project. This testing also includes the electrical/ instrumentation systems from the Zatory Pump Station to the Hofa Reservoir. The Contractor shall demonstrate the ability to operate/control those facilities locally as well as from the Operations Center at Zatory Pump Station.
- B It is the intent that all pumping, electrical and instrumentation equipment be fully tested, both individually and as complete systems, both manually and in the fully automatic mode, through the simulation or actual occurrence of all required or Engineer directed operating and sequencing conditions.
- C Pre-Commissioning activities will commence on-site approximately 2 months prior to the expected date of issuance of the Certificate of Completion for the facilities.
- D This item includes the necessary coordination, scheduling, and interfacing with the Contractor installing equipment and performing work on other projects in the Project Area so that there will be no delays or other problems associated with pre-commissioning, testing, and putting the new facilities into service.

1.02 PRE-COMMISSIONING SERVICES TO BE PROVIDED

- A Complete a pre-commissioning Work Plan to be submitted to the Engineer in accordance with Section 01300 at least 120 days prior to the expected date of issuance of the Certificate of Completion. The pre-commissioning Work Plan shall contain at a minimum the following:
 - 1. Contractor's schedule for testing and start-up of all pumping and electrical/instrumentation equipment taking into account the necessary interfacing with, and testing of, the electrical instrumentation systems at the Operations Center at the Zatory Pump Station.
 - 2. Schedule of visits by factory representatives for equipment testing and start-up and operator training.
 - 3. Schedule for pre-commissioning of the pump station that will allow to operate independently with their associated and/or connected storage and transmission/distribution systems, etc., under the following actual or simulated operating conditions:

- a. Operation of all pumps and equipment at low, average, and peak flow conditions.
 - b. Operation of all pumps and electrical/ instrumentation equipment under the various specified or Engineer directed operating conditions and sequences taking water from the existing Zatory reservoir and delivering to the Hofa and Um EL-LuLu Reservoirs, including the interaction of the control features in the system.
- B Submit all O&M manuals in final form in accordance with Section 01730 at least 60 days prior to the expected date of issuance of the Certificate of Completion.

3.0 EXECUTION

3.01 General

- A Upon approval of the pre-commissioning Work Plan, and with the written approval of the WAJ and the Engineer, the pre-commissioning activities may commence.
- B The pre-commissioning activities shall follow the approved Work Plan.
- C The Contractor shall be responsible for the operation and maintenance of all equipment and facilities furnishing all electrical power, etc., and paying all expenses associated with the pre-commissioning period.
- D In the event of failure to demonstrate satisfactory performance of equipment or any facility on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made at the Contractor's expense, when the equipment or facility is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the equipment or facility has operated continuously to the satisfaction of the Employer and Engineer, for the specified duration.
- E Do not, at any time, during startup allow any equipment or facility to be operated in a manner which subjects equipment to conditions that are more severe than the maximum allowable operating conditions for which the equipment was designed.

3.02 PREPARATION FOR PRE-COMMISSIONING

1. Upon completion of the pump station facilities and pipeline and all its related systems, all channels, sumps and pipes shall be flushed with potable water and

hydraulically checked for leaks, cracks, and defects. They shall also be disinfected in accordance with AWWA C6533.

2. All mechanical and electrical equipment shall be checked to insure that it is in good working order and properly connected. Preliminary operating tests of the various pumps, and other equipment shall be made. All systems shall be cleaned and purged as required.
3. All instruments and controls shall be calibrated through their full range. All other adjustments required for proper operation of all instrumentation and control equipment shall be made.
4. Perform all other tasks needed for preparing and conditioning the various equipment and for proper operation.
5. No testing or equipment operation shall take place until it has been verified by the Engineer that all specified safety equipment has been installed and is in good working order.
6. No testing or equipment operation shall take place until it has been verified by the Engineer that all lubricants, tools, maintenance equipment, spare parts and approved equipment operation and maintenance manuals have been furnished as specified.

END OF SECTION

**SECTION 01730
OPERATION AND MAINTENANCE DATA**

PART 1: GENERAL

1.01 SCOPE OF WORK

- A This section includes procedural requirements for compiling and submitting operation and maintenance data require to complete the project.

1.02 RELATED WORK

- A Submittals are included in Section 01300.

1.03 SERVICES OF MANUFACTURERS' REPRESENTATIVE

- A Equipment furnished under this contract shall include the cost of a competent representative of the manufacturers of all equipment to supervise the installation, adjustment, and testing of the equipment and to instruct the Owner's operating personnel on operation and maintenance. This supervision may be divided into two or more time periods as required by the installation program or as directed by the Engineer.
- B See the detailed Specifications for additional requirements for furnishing the services of manufacturer's representatives.
- C A certificate, in the form attached to this Section, from the manufacturer and signed by Owner's representative stating that the installation of the equipment is satisfactory, that the unit has been satisfactorily tested, is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit shall be submitted for each piece of equipment indicated above.
- D For equipment furnished under other Divisions, the Contractor shall furnish the services of accredited representatives of the manufacturer only when some evident malfunction or over-heating makes such services necessary in the opinion of the Engineer.

1.04 OPERATION AND MAINTENANCE MANUALS

- A Submit three preliminary copies of all operation and maintenance manuals to the Engineer no later than 45 days following approval of the shop drawings for each piece of equipment. These manuals will be reviewed by the Engineer and comments will be given to the Contractor for incorporation into the final operation and maintenance manuals.
- B Four complete sets, including one original, of the final operation and maintenance instructions covering all equipment furnished under this contract shall be delivered directly to the Engineer.

1. The manual for each piece of equipment shall be a separate document with the following specific requirements:

- a. Contents:

Table of contents and index

Brief description of each system and components

Starting and stopping procedures

Special operating instructions

Routine maintenance procedures

Emergency procedures

Manufacturer's printed operating and maintenance instructions, parts list, illustrations, and diagrams

One copy of each wiring diagram

One copy of each approved shop drawing and each Contractor's coordination and layout drawing

List of spare parts, manufacturer's price, and recommended on-hand quantity

Name, address and telephone numbers of local service representatives.

- b. Material:

Loose leaf on heavy duty paper

Page size, A4

Diagrams, illustrations, and attached foldouts as required, of original quality, reproduced by dry copy method

Covers: oil, moisture and wear resistant A4 size in a two ring binder.

1.05 CONTENTS, EACH VOLUME

- A Table of Contents: Provide title of Project, names, addresses, and telephone numbers of Engineer, subconsultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.
- B For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers; including local source of supplies and replacement parts.

- C Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- D Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- E Type Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified.
- F Warranties and Bonds where pertinent.

1.06 MANUAL FOR MATERIALS AND FINISHES

- A Building Products, Applied Materials, and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.
- B Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C Moisture Protection and Weather Exposed Products: Include product data listing, applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

1.07 MANUAL FOR EQUIPMENT AND SYSTEMS

- A For each Item of Equipment and Each System provide the following:
 1. Overview of System and description of unit or system, and component parts. Identify function, normal operating characteristics and limiting conditions. Include performance curves, with engineering data and tests and complete nomenclature and commercial number of replaceable parts.
 2. Panelboard Circuit Directories including electrical service characteristics, controls and communications, and color coded wiring diagrams as installed.
 3. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences; regulation, control, stopping, shut-down, and emergency instructions; and summer, winter, and any special operating instructions.
 4. Maintenance Requirements:
 - a. Routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

- b. Periodic preventive maintenance program for all electrical or mechanical equipment.
 - c. Servicing and lubrication schedule, and list of lubricants required.
 - d. Manufacturer's printed operation and maintenance instructions.
 - e. Sequence of operation by controls manufacturer.
 - f. Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
5. Control diagrams by controls manufacturer as installed.
6. Contractor's coordination drawings, with color coded piping diagrams as installed.
7. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
8. List of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
9. Test and balancing reports as specified.
10. Additional Requirements: As specified in individual product specification Sections.

1.08 INSTRUCTION OF OWNER PERSONNEL

- A Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times.
- B Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

PART 2: PRODUCTS

(NOT USED)

PART 3: EXECUTION

(NOT USED)

END OF SECTION

EASTERN PRIMARY TRANSMISSION SYSTEM PROJECT

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION TESTING AND INSTRUCTION

Owner _____ Contract No. _____
Project _____

EQUIPMENT SPECIFICATION SECTION _____ EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)
hereby CERTIFY that _____

(Print equipment name and model with serial No.)

installed for the subject project has been installed in a satisfactory manner, has been satisfactorily tested, is ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit[s] on Date: _____.

CERTIFIED BY: _____
(Signature of Manufacturer's Representative)

DATE: _____

OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

The undersigned, authorized representatives of the _____ and/or System Operating Personnel have received classroom and hands-on instruction on the operation, lubrication, and maintenance of the subject equipment and are prepared to assume normal operational responsibility for the equipment:

Name: _____ DATE: _____

Name: _____ DATE: _____

Name: _____ DATE: _____

SECTION 01740

WARRANTIES

PART 1: GENERAL

1.01 SCOPE OF WORK

- A This Section specifies general administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers standard warranties on products and special warranties.

1.02 DEFINITIONS

- A Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- B Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.03 RELATED WORK

- A Refer to Conditions of Contract for the general requirements relating to warranties.
- B General closeout requirements are included in Section 01710 Contract Closeout.
- C Specific requirements for warranties for the Work and products and installations that are specified to be warranted, are included in the individual Sections of the Divisions.

1.04 SUBMITTALS

- A Submit written warranties to the Owner prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Owner.
- B Refer to individual Sections of the Divisions for specific content requirements, and particular requirements for submittal of special warranties.
- C At Final Completion compile two copies of each required warranty properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Technical Specification.

- D Bind warranties in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive A4 paper.
- E Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Technical Specifications, with each item identified with the number and title of the specification Section in which specified, and the name of the product or work item.
- F Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer, supplier and manufacturer.
- G Identify each binder on the front and the spine with the typed or printed title "WARRANTIES", the Project title or name, and the name, address and telephone number of the Contractor equipment supplier and responsible principal.
- H When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.05 WARRANTY REQUIREMENT

- A Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the contract Documents.

1.06 MANUFACTURERS CERTIFICATIONS

- A. Where required, the Contractor shall supply evidence, satisfactory to the Engineer, that the Contractor can obtain manufacturers' certifications as to the Contractor's installation of equipment.

PART 2: PRODUCTS

(NOT USED)

PART 3: EXECUTION

(NOT USED)

END OF SECTION

SECTION 02050

DEMOLITION AND MODIFICATIONS

PART 1. GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and demolish, modify, remove and dispose of work shown on the Drawings and as specified herein.
- B. Included, but not limited to, are demolition, modifications and removal of existing materials, equipment or work necessary to install the new work as shown on the Drawings and as specified herein and to connect with existing work in approved manner.
- C. Demolition, modifications and removals that may be specified under other Sections shall conform to requirements of this Section.
- D. Demolition and modifications include:
 - 1. Remove existing office front green area and walkways,
 - 2. Remove existing path ways, including tiles and curb as per the Drawings
 - 3. Relocating existing galvanized pipes out of the new control room's footprint.
 - 4. Reinstallation existing water pipelines in trenches as shown on the Drawings
 - 5. Remove existing cables and trenches as shown on the drawings; hand over all removed cables to the WAJ.
- E. Blasting and the use of explosions will not be permitted for any demolition work.

1.02 RELATED WORK

- A. Summary of Work is included in Section 01010.
- B. Clearing is included in Section 02100.
- C. Excavation and Backfill is included in Section 02200.
- D. Construction Schedule is included in Section 01311.
- E. Submittals are included in Section 01300.
- F. Environmental Protection is included in Section 01110.

1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, six copies of proposed methods and operations of demolition of the structures and modifications prior to the start of work. Include in the schedule the coordination of shutoff, capping and continuation of utility service as required.
- B. Furnish a detailed sequence of demolition and removal work to ensure the uninterrupted progress of the Owner's operations.

- C. Before commencing demolition work, all modifications necessary to bypass the affected structure shall be completed. Actual work shall not begin until the Engineer has inspected and approved the modifications and authorized commencement of the demolition work in writing.

1.04 JOB CONDITIONS

A. Protection

1. Execute the demolition and removal work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.
2. Closing or obstructing of roadways, sidewalks and passageways adjacent to the work by the placement or storage of materials will not be permitted and all operations shall be conducted with a minimum interference to traffic on these ways.
3. Erect and maintain barriers, lights, sidewalk sheds and other required protective devices.

B. Scheduling

1. Carry out operations so as to avoid interference with operations and work in the existing facilities.

C. Notification

1. At least 48 hours prior to commencement of a demolition or removal, notify the Engineer in writing of proposed schedule therefore. Owner shall inspect the existing equipment and to identify and mark those items which are to remain the property of the Owner. No removals shall be started without the permission of the Engineer.

D. Conditions of Structures

1. The Owner and the Engineer assume no responsibility for the actual condition of the structures to be demolished or modified.
2. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner insofar as practicable. However, variations within a structure may occur prior to the start of demolition work.

E. Repairs to Damage

1. Promptly repair damage caused to adjacent facilities by demolition operation when directed by Engineer and at no cost to the Owner. Repairs shall be made to a condition at least equal to that which existed prior to construction.

F. Traffic Access

1. Conduct demolition and modification operations and the removal of equipment and debris to ensure minimum interference with roads, streets, walks both onsite and offsite and to ensure minimum interference with occupied or used facilities.
2. Special attention is directed towards maintaining safe and convenient access to the existing facilities by plant personnel and plant associated vehicles.

3. Do not close or obstruct streets, walks or other occupied or used facilities without permission from the Engineer. Furnish alternate routes around closed or obstructed traffic in access ways.

1.05 RULES AND REGULATIONS

- A. The prevailing statutory regulations shall control the demolition, modification or alteration of the existing buildings or structures.
- B. No building or structure, or any part thereof, shall be demolished until an application has been filed with the Owner and a permit or consent issued.

1.06 DISPOSAL OF MATERIAL

- A. Salvageable material and equipment listed hereinafter shall become the property of the Owner. Dismantle all such items to a size that can be readily handled and deliver them to a designated storage area.
- B. The following materials and items of equipment shall remain the property of the Owner and stored where directed on the site. Any such material damaged due to improper handling will not be accepted and the replacement value of the material deducted from the payment to the Contractor.
 1. All mechanical equipment (overhead crane)
 2. All valves, fittings, and pipes of any condition
 3. Doors, windows, and any other items required by the Engineer and/or by WAJ representative.
- C. All other material and items must be removed from the site.
- D. The storage or sale of removed items on the site will not be allowed.

PART 2. PRODUCTS (NOT USED)

PART 3. EXECUTION

3.01 GENERAL

- A. All materials and equipment removed from existing work shall be removed from the site, except for those that the Owner has identified and marked for his use. All materials and equipment marked by the Owner to remain shall be carefully removed, so as not to be damaged, and handed over to the owner representative.
- B. Dispose of all demolition materials, equipment, debris and all other items not marked by the Owner to remain, off the site and in conformance with all existing applicable laws and regulations.
- C. Pollution Controls
 1. Use water sprinkling, temporary enclosures and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
 - a. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding and pollution.

- b. Clean adjacent structures, facilities, and improvements of dust, dirt and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the work.

D. Building Demolition

1. Unless otherwise approved by Engineer, proceed with demolition from the top of the structure to the ground. Complete demolition work above each floor or tier before disturbing supporting members of lower levels.
2. Demolish concrete and masonry in small sections.
3. Remove structural framing members and lower to ground by means of hoists, derricks, or other suitable methods.
4. Break up and remove foundations and slabs-on-grade, unless otherwise approved by the Engineer and if not in conflict with new structures or installations.
5. Locate demolition equipment throughout the structure and remove material so as to not impose excessive loads to supporting walls, floors or framing.

3.02 STRUCTURAL REMOVALS

- A. Remove structures to the lines and grades shown unless otherwise directed by the Engineer. Where no limits are shown, the limits shall be 100 mm outside the item to be installed. The removal of masonry beyond these limits shall be at the Contractor's expense and these excess removals shall be reconstructed to the satisfaction of the Engineer with no additional compensation to the Contractor.
- B. All concrete, brick, tile, concrete block, roofing materials, reinforcement, structural or miscellaneous metals, plaster, wire mesh and other items contained in or upon the structure shall be removed and taken from the site. Demolished items shall not be used in backfill adjacent to structures or in pipe line trenches.
- C. After removal of parts or all of masonry walls, slabs and like work which tie into new work or existing work, the point of junction shall be neatly repaired so as to leave only finished edges and surface exposed.

3.03 MECHANICAL REMOVALS

- A. Mechanical removals shall consist of dismantling and removing of existing piping, equipment and other appurtenances as specified, shown, or required for the completion of the work. It shall include cutting, capping, and plugging as required, except that the cutting of existing piping for the purpose of making connections thereto will be included under Division 15.
- B. Existing process, water, chemical, gas, fuel oil and other piping not required for the new work shall be removed where shown or where it will interfere with new work. Piping not indicated to be removed or which does not interfere with new work shall be removed to the nearest solid support, capped and left in place. Chemical and fuel lines and tanks shall be purged and made safe prior to removal or capping. Where piping that is to be removed passes through existing walls, it shall be cut off and properly capped on each side of the wall.
- C. When underground piping is to be altered or removed, the remaining piping shall be properly capped. Abandoned underground piping may be left in place unless it interferes with new work or is shown or specified to be removed.

- D. Any changes to potable water piping and other plumbing and heating system work shall be made in conformance with all applicable codes and under the same requirements as other underground piping. All portions of the potable water system that have been altered or opened shall be pressure tested and disinfected in accordance with Section 01445 and local codes. Other plumbing piping and heating piping shall be pressure tested only.

3.04 ELECTRICAL REMOVALS

- A. Electrical removals shall consist of the removal of existing conduits and wires, poles and overhead wiring, lighting fixtures and miscellaneous electrical equipment all as shown on the Drawings, specified herein, or required to perform the work.
- B. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation and to maintain the integrity of the grounding systems.
- C. Conduits and wires shall be abandoned or removed as needed. All wires in abandoned conduits shall be removed. Abandoned conduits concealed in floor or ceiling slabs or in walls, shall be cut flush with the slab or wall at the point of entrance. The conduits shall be suitable plugged and the area repaired in a flush, smooth and approved manner. Exposed conduits and their supports shall be disassembled and removed from the site. Repair all areas of work to prevent rust spots on exposed surfaces.
- D. Where shown or otherwise required, wiring in the underground duct system shall be removed. Verify the function of all wiring before disconnection and removing it. Ducts that are not to be reused shall be plugged where they enter buildings and made watertight.
- E. Where shown, direct-burial cable shall be abandoned. Such cable shall be disconnected at both ends of the run. Where it enters a building or structure the cable shall be cut back to the point of entrance. All opening in buildings for entrance of abandoned direct-burial cable shall be patched and made watertight.
- F. Light poles and wiring shall be removed as shown and specified. Perform this work after the proposed service has been completed and energized, and in accordance with the approved schedule.
- G. Lighting fixtures shall be removed or relocated as shown. Fixtures not relocated shall be handed over to owner representative.
- H. Wall switches, receptacles, and other miscellaneous electrical equipment, shall be removed and disposed of off the site as required.

3.05 CLEAN-UP

- A. Remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the work, all materials, equipment, waste and debris of every sort shall be removed and premises shall be left, clean, neat and orderly.

END OF SECTION

SECTION 02100
SITE PREPARATION

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, and equipment required and perform all site preparation, complete as shown on the Drawings and as specified herein.
- B Obtain all permits required for site preparation work prior to proceeding with the work.
- C The areas to be cleared, grubbed, and stripped within public rights-of-way and utility easements shall be minimized to the extent possible for the scope of pipeline work and in consideration of the actual means and methods of construction used. No unnecessary site preparation within these areas shall be performed.
- D Refer to Section 108 of the WAJ Specs for Sewerage Works for special precautions and requirements for archaeological remains and artifacts revealed during the Work process.

1.02 RELATED WORK

- A Earthwork for structures is included in Section 02200.

1.03 SUBMITTALS

- A Submit to the Engineer copies of all permits required prior to clearing, grubbing, and stripping work.

PART 2: PRODUCTS

- A None this section

PART 3: EXECUTION

3.01 CLEARING

- A Cut and remove all trees, stumps, brush, shrubs, roots, grass, weeds, rubbish, and any other objectionable material resting on or protruding through the surface of the ground.
- B Trees and other vegetation designated on the Drawings, if any, or directed by the Engineer to remain shall be preserved and protected as specified below.

3.02 GRUBBING

- A Grub and remove all stumps, roots in excess of 35 mm in diameter, matted roots, brush, logs, concrete rubble, and all other debris encountered to a depth of 300 mm below original grade or 300 mm beneath the bottom of foundations, whichever is lower.
- B All grubbing holes and depressions excavated below the original ground surface shall be refilled with suitable materials and compacted to a density conforming to the surrounding ground surface in accordance with Section 02200.

3.03 STRIPPING

- A Strip topsoil if any and as directed by the Engineer from all areas to be occupied by buildings, structures, and roadways, and all areas to be excavated or filled.
- B Topsoil shall be free from brush, trash, large stones and other extraneous material. Avoid mixing topsoil with subsoil.
- C Stockpile and protect topsoil if it is to be used in landscaping operations. Dispose of surplus topsoil after all work is completed.

3.04 DISPOSAL

- A Material and debris from site preparation operations shall be disposed of by hauling such materials and debris to an approved offsite disposal area. No rubbish or debris of any kind shall be permitted to be buried on the project site.
- B Burning of cleared and grubbed materials, or other fires for any reason will not be permitted.

3.05 PROTECTION

- A Trees and other vegetation designated on the Drawings or directed by the Engineer to remain shall be protected from damage by all construction operations by erecting suitable barriers, guards, and enclosures, or by other approved means. Clearing operations shall be conducted in a manner to prevent falling trees from damaging trees and vegetation designated to remain and to the work being constructed and so as to provide for the safety of employees and others.
- B Protection shall be maintained until all work in the vicinity of the work being protected has been completed.
- C Heavy equipment operation or stockpiling of materials shall not be permitted within the branch spread of existing trees.
- D Any damage to existing tree branches, trunks, or root systems shall be repaired immediately. Roots exposed and/or damaged during the work shall immediately be cut off cleanly inside the exposed or damaged area. Cut surfaces shall be treated with an acceptable tree wound paint, and topsoil spread over the exposed root area.

- E When work is completed, all dead and downed trees shall be removed. Live trees shall be trimmed of all damaged limbs and branches. All cuts shall be cleanly made at their juncture with the trunk or preceding branch without injury to the trunk or remaining branches. Cuts over 25 mm in diameter shall be treated with an acceptable tree wound paint.

- F Construction activities shall be restricted to those areas within the limits of construction designated on the Drawings, within public rights-of-way, and within easements provided by the Owner. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations shall be promptly restored to their original condition, to the full satisfaction of the property owner.

END OF SECTION

SECTION 02200

EARTHWORK FOR STRUCTURES

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals necessary to perform all excavation, backfill, fill and grading required to complete the work shown on the Drawings and specified herein. The work shall include, but not necessarily be limited to: excavation for structures, footings, manholes, vaults, electrical manholes, handholes; all backfilling and fill; embankment and grading; disposal of waste and surplus materials; and all related work such as sheeting, bracing and pumping.
- B All excavation, trenching, and related sheeting, bracing, etc., shall comply with the requirements of OSHA excavation safety standards 29 CFR Part 1926.650 Subpart P and local Jordanian regulations and requirements. Where conflict between OSHA and Jordanian regulations exists, the more stringent requirements shall apply.
- C Refer to Section 01040 for special precautions to be taken in significantly important archeological areas.

1.02 RELATED WORK

- A Site Preparation is included in Section 02100.
- B Rock and Boulder Excavation and Removal is included in Section 02213.
- C Trenching, Backfilling, and Compaction are included in Section 02222.
- D Pavement Repair and Resurfacing is included in Section 02575.

1.03 REFERENCE STANDARDS

- A American Society for Testing and Materials (ASTM)
 - 1. ASTM C33 - Specification for Concrete Aggregates.
 - 2. ASTM D1557 - Test Method for Moisture Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (457mm) Drop.
 - 3. ASTM D2487 - Standard Test Method for Classification of Soils for Engineering Purposes.
- B Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 PROTECTION

A Sheeting and Bracing

1. Furnish, put in place and maintain such sheeting and bracing as may be required to support the sides of excavations; to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction; and to protect adjacent structures from undermining or other damage. If the Engineer is of the opinion that at any points sufficient or proper supports have not been provided, he may order additional supports put in, and compliance with such order shall not relieve or release the Contractor from his responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed. Where soil cannot be properly compacted to fill a void, lean concrete shall be used as backfill.
2. Construct the sheeting outside the neat lines of the foundation, unless indicated otherwise, to the extent deemed desirable for the method of operation. Sheeting shall be plumb and securely braced and tied in position. Sheeting and bracing shall be adequate to withstand all pressures to which the structure or trench will be subjected. Any movement or bulging which may occur shall be corrected to provide the necessary clearances and dimensions.
3. All sheeting and bracing not left in place shall be carefully removed in such manner as not to endanger the construction or other structures, utilities, or property. In no case shall sheeting which is driven below the springline of any pipe be withdrawn; such sheeting shall be left in place and cut off at least 3 meters below the finished ground level. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, or otherwise as may be directed.

1.05 SOIL TESTING

- A Previous to the general placement of the fill and during such placement, the Engineer may select areas within the limits of the fill for testing the degree of compaction obtained. The Contractor shall cooperate fully in obtaining the information desired.
- B Payment for testing will be made by the Contractor. If test results are unsatisfactory, all costs involved in correcting deficiencies in compacted materials to the satisfaction of the Engineer will be borne by the Contractor.

PART 2: PRODUCTS

2.01 MATERIALS

A Structural Fill

1. Structural Fill shall be gravel, sandy gravel, or gravelly sand free of organic material, loam, wood, trash and other objectionable material with a plasticity index of no greater than 15, and shall be well graded within the following limits:

<u>Sieve Size (mm)</u>	<u>Percent Passing by Weight</u>
20	100
16	80 - 95
12.5	50 - 80
8.0	30 - 70
4.8	20 - 50
0.50	5 - 20
0.15	0 - 10

2. The Contractor shall submit a representative sample of proposed structural fill, weighing approximately 25 kg, at least five days prior to the date of anticipated use of such material.

B Common Fill shall consist of mineral soil substantially free from organic materials, loam, wood, trash and other objectionable materials having a plasticity index no greater than 30, which may be compressible or which cannot be properly compacted. Common fill shall not contain stones larger than 38 mm in largest diameter and shall be well graded. Common fill shall not contain stone blocks, broken concrete, masonry rubble or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling.

C Select Common Fill shall be as specified above for Common Fill except that the material shall contain no stones larger than 19 mm in largest dimension.

PART 3: EXECUTION

3.01 EXCAVATION BELOW GRADE

A If the bottom of any excavation is taken below the limits shown on the Drawings, specified, or directed by the Engineer, it shall be refilled at the Contractor's expense with 150 mm layers of compacted structural fill or other material satisfactory to the Engineer. The type of material to be used shall be at the Engineer's option.

B If the Contractor does not care for water properly, through failure to postpone final excavation immediately above the subgrade until shortly before placing of the new work thereon, or other failure or neglect to conduct the excavation work properly so that the surface of the subgrade is in proper condition when he is ready for construction, the Contractor shall remove the unsuitable material and replace it with concrete, compacted structural fill, or other approved material at his own expense so that the condition of the subgrade meets with the approval of the Engineer before any work is placed thereon.

C If, in the opinion of the Engineer, the material, in its undisturbed natural condition, at or below the normal grade of the excavation as indicated on the Drawings is unsuitable for foundations, it shall be removed to such depth and width as he may direct and be replaced with suitable material as directed by the Engineer.

3.02 STRUCTURE EXCAVATION

- A Excavation shall be made to the grades shown on the Drawings and to such widths as will give suitable room for construction of the structures, for bracing and supporting, pumping and draining. The bottom of the excavations shall be rendered firm and dry and in all respects acceptable to the Engineer.
- B Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. Exposed subgrades shall be proofrolled with at least two coverages of the specified equipment. The Engineer shall waive this requirement if, in his opinion, the subgrade will be rendered unsuitable by such compaction. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory for support of structures as a result of inadequate excavation, dewatering, proofrolling, or other construction methods shall be removed and replaced by structural fill as required by the Engineer at the Contractor's expense.
- C Dewatering shall be such as to prevent boiling or detrimental underseepage at the base of the excavation as specified herein before.
- D Excavation equipment shall be satisfactory for carrying out the work in accordance with the Specifications. In no case shall the earth be plowed, scraped, or dug with machinery so near to the finished subgrade as to result in excavation of, or disturbance of, material below grade, the last of the excavated material being removed with pick and shovel just before placing of concrete or working mat thereon.
- E When excavation for foundations has reached prescribed depths, the Engineer shall be notified and will inspect conditions. If materials and conditions are not satisfactory to the Engineer, the Engineer will issue instructions as to the procedures and if additional costs are involved, adjustments of the Contract Price will be made on the basis of unit prices agreed upon by the Owner and the Contractor in accordance with the provisions of the Contract Documents.
- F During final excavation to subgrade level, take whatever precautions are required to prevent disturbance and remolding. Material which has become softened and mixed with water shall be removed. Hand excavation of the final 75 mm to 150 mm will be required as necessary to obtain a satisfactory undisturbed bottom. The Engineer will be the sole judge as to whether the work has been accomplished satisfactorily.

3.03 EXCAVATION AND BACKFILLING FOR FOOTINGS AND UNDERSLAB TRENCHES

- A Excavation for all pipe lines beneath structures and excavation for all footings shall be carried out with the excavating equipment operating from the subgrade for the structure. The excavation shall be carried out "in-the-dry" and in a manner which will preserve the undisturbed state of the subgrade soils. The excavations may be completed with shoring and bracing of open cuts.
- B All excavation beneath structures shall be backfilled with structural fill. Where it is impractical to use large equipment for compaction or when such methods, in the opinion of

the Engineer, are disturbing the surrounding natural subgrade, the fill shall be compacted using hand-operated mechanical compactors. The lift thickness shall not exceed 150 mm measured before compaction when hand-operated equipment is used.

3.04 MISCELLANEOUS EXCAVATION

- A The Contractor shall perform all the remaining miscellaneous excavation. The Contractor shall make all excavations necessary to permit the placing of loam and plants, for constructing roadways, and any other miscellaneous earth excavation required under this Contract.

3.05 BACKFILLING - COMMON FILL

- A Common Fill may be used as fill against exterior walls of structures (except water and retention structures); as embankment fill; or in other areas as designated by the Engineer. Material conforming to the requirements of Common Fill shall be placed in layers having a maximum thickness of 200 mm measured before compaction.
- B Common Fill shall be compacted to at least 92 percent of maximum density as determined by ASTM D1557, Method D.
- C Materials placed in fill areas shall be deposited to the lines and grades shown on the Drawings making due allowance for settlement of the material and for the placing of loam thereon.
- D The surfaces of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the grading plan and no soft spots or uncompacted areas will be allowed in the work.
- E No compacting shall be done when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have dried sufficiently to permit proper compaction.

3.06 BACKFILLING - STRUCTURAL FILL

- A Structural Fill shall be placed in layers having a maximum thickness of 150 mm including points where conduit and piping join structures, measured before compaction. Each layer of fill shall be compacted to at least 95 percent of maximum dry density determined by the ASTM D1557, Method D by methods approved by the Engineer. The limits of structural fill adjacent to structures shall extend as shown on the Drawings.
- B Structural fill shall not be placed on a frozen surface or one covered by snow or ice, nor shall snow, ice or frozen earth be incorporated in the compacted fill.
- C Compaction of structural fill in open areas shall be performed by a suitably weighted roller specifically designed for compacting earthen material which will not create lamination or instability in the fill, or any other method approved by the Engineer. Compaction of structural fill in confined areas shall be accomplished by hand operated vibratory equipment or mechanical tampers approved by the Engineer. As a minimum, compaction of structural

fill shall consist of a minimum of four coverages of the approved equipment; however, this procedure shall not take precedence when the resultant compaction does not meet the specified requirements.

3.07 EARTH EMBANKMENTS-COMMON FILL

- A All organic materials, including peat and loam, and loose inorganic silt material (loess) shall be removed from areas beneath new embankments. If the subgrade slopes are excessive, the subgrade shall be stepped to produce a stable surface for the placement of the embankments. The natural subgrade shall then be compacted by at least two coverages of a loaded six-wheel or ten-wheel truck. The Engineer will waive this requirement, if, in his opinion, the subgrade will be rendered unstable by such compaction. The prepared subgrade shall be inspected and approved by the Engineer prior to the placement of structural fill.

3.08 DISPOSAL OF SURPLUS OR UNSUITABLE MATERIAL

- A Suitable excavated material shall be used for fill embankments or backfill on the different parts of the work as required.
- B Surplus or unsuitable material shall become the property of the Contractor and shall be removed and disposed of by him off the site.

3.09 DISPOSAL AND REPLACING OF ROCK

- A The Contractor shall remove and dispose of all pieces of ledge and boulders which are not suitable for use in other parts of the work. Rock disposed of by hauling away to spoil areas is to be replaced by approved surplus excavation obtained elsewhere on the work, insofar as it is available. Any deficiency in the backfill material shall be made up with acceptable material approved by the Engineer.

3.10 GRADING

- A Grading in preparation for placing of loam, planting areas, paved walks and drives and appurtenances shall be performed at all places that are indicated on the Drawings, to the lines, grades and elevations shown and otherwise as directed by the Engineer and shall be performed in such a manner that the requirements for formation of embankments can be followed. All material encountered, of whatever nature, within the limits indicated, shall be removed and disposed of as directed. During the process of grading, the subgrade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.
- B If at the time of grading it is not possible to place any material in its final location, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.
- C The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses, in order to obtain satisfactory construction.

- D Stones or rock fragments larger than 100 mm in their greatest dimensions will not be permitted in the top 150 mm of the finished subgrade of all fills or embankments.
- E In cuts, all loose or protruding rocks on the back slopes shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings or as directed by the Engineer.

END OF SECTION

SECTION 02213

ROCK AND BOULDER EXCAVATION AND REMOVAL

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment, and incidentals required to excavate and dispose of rock and boulders as specified herein.
- B Blasting will not be permitted on this project.

1.02 RELATED WORK

- A Earthwork for Structures is included in Section 02220.
- B Trenching, Backfilling and Compaction are included in Section 02222.
- C Environmental Protection is included in Section 01036.

1.03 SUBMITTALS

A General

Submit in accordance with Section 01300 the proposed methods of excavation and removal for the various portions of the Work. Contractor shall remain responsible for ways, means, methods, and techniques, as well as all safety considerations.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION GENERAL

3.01 ROCK AND BOULDER EXCAVATION

- A Rock excavation may be performed by hoe-ramming, ripping, jack hammering, expansive chemical splitting, or other approved process.
- B The Contractor assumes all responsibility for the safety and proper protection of personnel, structures, equipment, utilities, facilities, etc., during the performance of this and all other related work items.

3.02 DISPOSAL OF ROCK AND BOULDERS

- A Fragmented rock up to 300 mm in length in any direction may be used as riprap, provided that such materials meet the requirements for riprap specified in Section 02271.

- B Rock and boulders may be crushed and screened for reuse in the Work, provided that the resultant materials meet the requirements for gravel, crushed stone, or structural fill as specified in Sections 02200 and 02222.
- C Unused rock and boulders shall be removed and disposed of at an approved off-site location.

END OF SECTION

SECTION 02222

TRENCHING, BACKFILLING AND COMPACTION

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals necessary to perform all trenching for pipelines and appurtenances, including drainage, filling, backfilling, disposal of surplus material and restoration of trench surfaces and easements.
- B Excavation shall extend to the width and depth shown on the Drawings or as specified and shall provide suitable room for installing pipe, structures and appurtenances.
- C The Contractor shall furnish and place all sheeting, bracing and supports and shall remove from the excavation all materials which the Engineer may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry and in all respects, acceptable. If conditions warrant, the Contractor may be ordered to deposit gravel for pipe bedding, or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be related closely to the rate of pipe laying. All excavation shall be made in open trenches.
- D All excavation, trenching, and related sheeting, bracing, etc., shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and WAJ General Technical Specifications (1995) Sections 100, 200 and 300. Where conflict between OSHA and other specifications exists, the more stringent requirements shall apply.
- E Unless otherwise specified, all compaction shall be at least 95 percent of the maximum dry density in accordance with ASTM D1557, Method D.
- F Prior to the start of work the Contractor is required to submit his proposed method of backfilling and compaction to the Engineer for review.

1.02 RELATED WORK

- A Site Preparation is included in Section 02100
- B Earthwork for Structures is included in Section 02200
- C Surface and Groundwater Control is included in Section 02401
- D Roadway Pavement is included in Section 02510.
- E Concrete work is included in Division 3

1.03 EXCAVATION SUPPORT SYSTEM DESIGN CRITERIA

- A The Contractor has sole responsibility for the adequacy of excavation support systems, preventing damage to adjacent structures and other work, and job safety. Excavation support systems shall be designed to support the sides of excavations such that damage to adjacent structures by undermining or excessive ground movements outside the excavation is prevented.
- B Excavation support system design shall account for all soil and water pressures and surcharges from traffic, adjacent structures, material stockpiles, construction equipment or any other loads which will be imposed on the system at any stage of excavation and bracing and construction of the Work.
- C Design the excavation support system for staged removal of bracing in accordance with the sequence of concrete placement and backfilling.
- D Design calculations and shop drawings for the excavation support system shall be prepared by an experienced professional engineer employed by or retained by the Contractor.
- E Review of the Contractor's shop drawings, design calculations and methods of construction by the Engineer does not relieve the Contractor of sole responsibility for the adequacy of excavation support systems, preventing damage to adjacent structures and other work, and job safety.
- F The qualifications and experience record of the Contractor's designer of excavation support system(s) shall be subject to approval by the Engineer. The designer of the excavation support system shall have a total of 10 years experience, with a minimum of 2 years experience, with excavation support system design.

1.04 TESTING AND MONITORING

- A In-place soil compaction tests shall be performed by an independent testing laboratory employed by and at the expense of the Contractor as specified in Section 01410.
The Engineer shall review all testing procedures and equipment for conformance with ASTM procedures. In the event the independent laboratory is not performing required testing to the satisfaction of the Engineer, the Engineer shall direct the Contractor to discontinue the services of the independent laboratory and, at no cost to the Owner, employ the services of another laboratory acceptable to the Engineer.
- B The following methods of testing will be required.
 - 1. Gradation tests shall be in accordance with ASTM D422 and ASTM D2217. One test shall be required for each type of backfill material at average intervals not to exceed 500 meters of trench length.
 - 2. Maximum density and optimum moisture content determination for Common Fill and Select Common Fill shall be in accordance with ASTM D1557. One test shall be required for each type of backfill material at average intervals not to exceed 500 meters of trench length.

3. For area fills, an in-place field density test will be required for each 1000 m³ of material placed. For pipelines, one in-place density test will be required at average intervals not exceeding 100 meters of trench length.
4. In-place field density test procedures shall provide for immediate on-site determination of percent compaction. Results are to be reported on the same day to the Engineer.

1.05 SAFETY AND PROTECTION OF LIFE AND PROPERTY

- A The Contractor has sole responsibility for preventing damage to adjacent structures and other work, and for job safety during execution of the Work. Excavation support systems where required, shall be designed to support the sides of excavations such that damage to adjacent structures by undermining or excessive ground movements outside the excavation is prevented.
- B Trench sides may be sloped or stepped only in those areas where the increased trench width will not interfere with existing surface features or the limits of permanent rights-of-way. Trench sides shall be of sufficient slope to prevent caving or sliding. Slopes shall not extend lower than the limits shown on the Drawings. Use of sloped or battered trench sides is subject to acceptance of the Engineer.
- C The Contractor shall furnish, put in place, and maintain such sheeting and bracing as may be required to support the sides of excavations, to prevent any movement which could any way diminish the width of the excavation below that necessary for proper construction, and to protect adjacent structures from undermining or other damage. Use of open sheeting is not acceptable.
- D The sheeting and bracing installed shall be in conformity with the design, and certification of this shall be provided by the sheeting and bracing design engineer in accordance with the requirements of this Specification.
- E Sheeting and bracing design shall account for all soil and water pressures and surcharges from traffic, adjacent structures, material stockpiles, construction equipment or any other loads which will be imposed on the system at any stage of excavation and bracing and construction of the Work.

1.06 EXCAVATION RESTRICTIONS

- A Access for pedestrians shall be maintained to structures and residences adjacent to the work at all times during construction.
- B Utilities servicing structures and residences adjacent to the Work shall be maintained at all times during construction.
- C Excavation shall proceed "in-the-dry". Control surface water and groundwater as specified in Section 02401.
- D In heavily congested areas and where maintaining one way traffic shall be limited to no more than 50 meters.

1.07 OTHER REQUIREMENTS AND RESTRICTIONS

- A The Contractor shall adhere to the applicable requirements of all ordinances, codes and regulations of authorities having jurisdiction over safety of excavations.
- B Active utility lines damaged in the course of construction operations shall be repaired by the Contractor or replaced immediately at no cost to the Employer.
- C The Contractor shall conduct earthwork operations to control dust, noise, vibrations and maintain clean streets accessing the site.

PART 2: PRODUCTS

2.01 MATERIALS FOR EXCAVATION SUPPORT

- A Steel Sheet Piles shall be continuous interlocking type, ASTM A328 standard grade, non-damaged, with cross-sections selected for intended use.
- B Soldier Piles and Bracing: Structural steel for use as soldier piles and in bracing systems shall conform to the current edition of "AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings".
- C Timber: Structural grade having a minimum allowable working stress of 1100 psi. Basis for determination of minimum allowable working stress shall be ASTM D2555 and ASTM D245.
- D Welding: Welding shall conform to American Welding Society Code D1.0 for Welding in Building Construction.
- E Trench boxes shall be steel box designed with suitable wall thickness and cross bracing for excavations typical to this project.

2.02 EARTH MATERIALS

A Common Fill

- 1. Common Fill shall consist of mineral soil substantially free from organic materials, having a plasticity index no greater than 30, which may be compressible or which cannot be properly compacted. Common Fill shall not contain stones larger than 100mm in largest dimension and shall be well graded. Common Fill shall not contain stone blocks, broken concrete, masonry rubble or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling.
- B Select backfill material for trenches under dirt roads, footpaths and side walks shall conform to WAJ Section 303b where plasticity index should be less than 10, as determined by BS 1377, with a maximum dry density greater than 1.6 gram/cm³ according to Standard Proctor density and in accordance with ASTM D1557 Modified Proctor. In addition, it shall not contain stones larger than 50 mm in largest dimension.

- C Crushed stone for concrete pipe bedding shall be used for concrete pipe bedding as detailed and at other locations indicated on the Drawings. Crushed stone shall consist of hard, durable rock particles (crushed limestone will not be allowed) of proper size and gradation, and shall be free from sand, loam, clay, excess fines, and deleterious materials. Crushed Stone shall be capable of being spread to easily fill voids and shall be capable of being compacted with little effort. Crushed Stone shall be graded within the following limits:

Sieve Size in mm	Percent Passing (By Weight)
25	100
19	90 - 100
10	20 - 55
4.8	0 - 10
2.4	0 - 15

D Sand for Ductile Iron and UPVC Pipe Bedding

1. Sand for ductile iron pipe embedment shall consist of natural silica sand (Sweileh) or, subject to approval of the Engineer's Representative, other inert materials with similar characteristics having durable particles.
2. Sand from different sources of supply shall not be mixed or stored in the same pile nor used alternately in the same class of construction without permission from the Engineer's Representative.
3. Sand shall be uniformly graded and shall conform to the following grading requirements.

Sieve Designation	Percentage Passing By Weight (AASHTO T27)
9.5 mm	100
4.76 mm	95 - 100
1.19 mm	45 - 80
0.30 mm	10 - 30
0.15 mm	2 - 20

4. Sand shall not contain deleterious substances in excess of the following percentages:

AASHTO Test Method	Percentage By Weight
Clay lumps	T112 1
Coal and lignite	T113 1
Material passing No. 200 sieve	T11 3

Total deleterious substances, including the above and shale, alkali, mica, coated grains, and soft and flaky particles shall not exceed 6 percent by weight.

5. The Contractor shall submit to the Engineer's Representative samples of proposed sand. The proposed material must receive the approval of the Engineer's Representative prior to use on the Project.

E Select Graded Aggregate for Under Road Surfaces

1. The top 300 mm of pipe trench under road surfaces and pavements shall be filled, watered and compacted with select graded aggregate.
2. Select graded aggregate for first 300 mm under pavement shall be sound, naturally occurring material or angular crushed stone, clean and free from organic matter and unsuitable material or other deleterious substances and in such condition that it can be readily compacted under watering and rolling to form a firm and stable layer. It shall be graded as follows:

Sieve Size (mm)	Percent Passing by Weight
-----	-----
37.5	100
25.0	60 - 100
19.0	55 - 85
4.8	35 - 60
2.4	25 - 50
0.425	15 - 30
0.075	8 - 15

F Graded Aggregate for Trench Backfilling

1. Backfilling 300 mm under the pavement to the top of the pipe bedding shall be with graded aggregate.
2. Graded aggregate for the area 300 mm under pavement to the top of the pipe bedding shall be sound, naturally occurring material or angular crushed stone, clean and free from organic matter and unsuitable material or other deleterious substances and in such condition that it can be readily compacted under watering and rolling to form a firm and stable layer.

Sieve Size (mm)	Percent Passing by Weight
-----	-----
50	100
25	55 - 85
4.8	30 - 65
0.425	8 - 40
0.075	0 - 15

G Structural Fill

1. Structural Fill shall be used under pipeline structures if existing material is unsuitable. Structural Fill shall be graded as specified in Section 02200.
2. Where Structural Fill is used it shall be placed in 150 mm thick lifts with each lift compacted to at least 95 percent of maximum dry density as determined by ASTM D1557.

PART 3: EXECUTION

3.01 SITE PREPARATION

- A Ground surfaces within the construction areas of the working site shall be cleaned of all brush, debris, and surface vegetation. Stumps and roots shall be completely grubbed and removed. Matted roots shall be removed regardless of size. Surface vegetation shall be removed complete with roots to a depth of not less than 100 mm below the ground surface.
- B All areas and all trees shown on the Drawings or designated by the Engineer to remain, shall be protected from damage by all construction operations. Should additional trees or groups of trees have to be removed to carry out the Work, obtain permission from the proper authorities or owners and acceptance of the Engineer.
- C Clearing operations shall be conducted in a manner to prevent falling trees from damaging trees designated to remain. Protection of trees designated to be preserved shall include barrier or fence protection, trimming of trees and preventing stockpiled material from covering tree trunks.
- D All combustible and other waste material resulting from construction operations shall be removed within the limits shown and disposed of by and at the expense of the Contractor. Open burning is not permitted.
- E Remove and stockpile all topsoil within a minimum depth of 100 mm from surfaces to be excavated, from fills, and from any other areas on the site of the Work where the original ground surface will be covered or damaged. After all other Work has been completed in each area, topsoil shall be placed and graded to the satisfaction of the Engineer.

3.02 TRENCH EXCAVATION

- A Trench excavation shall include material of every description and of whatever substance encountered. Pavement shall be cut with a saw, wheel or pneumatic chisel along straight lines before excavating.
- B The Contractor shall strip and stockpile topsoil from agricultural or vegetated areas crossed by trenches. At the Contractor's option, topsoil may be otherwise disposed of and replaced, when required, with approved topsoil of equal quality.
- C While excavating and backfilling is in progress, traffic shall be maintained, and all utilities and other property protected.

- D Trenches shall be excavated to the depth indicated on the Drawings and in widths sufficient for laying the pipe, bracing and for pumping and drainage facilities. The bottom of the excavations shall be firm and dry and in all respects acceptable to the Engineer. Trench width shall be kept to a practical minimum.
- E Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The trench may be excavated by machinery to, or just below the designated subgrade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Subgrade soils which become soft or loose, or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by screened gravel fill as required by the Engineer at the Contractor's expense.
- F Clay and organic silt soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, the Contractor shall use a smooth-edge bucket to excavate the last 0.3 meter of depth.

3.03 DISPOSAL OF MATERIALS

- A Excavated material shall not be stacked on the trench bank to assure access to residences and alleyways. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.
- B It is expressly understood that no excavated material shall be disposed of by the Contractor except as directed by the Engineer. When disposal of surplus materials has been approved by the Engineer, the Contractor shall do so in areas approved by the Engineer and local authorities.
- C As a matter of general practice, the excavated material shall be hauled and stored at a location provided by the Contractor. When required, it shall be re-handled and used in backfilling the trench.

3.04 SHEETING AND BRACING

- A Sheeting shall be plumb and securely braced and tied in position. Sheeting and bracing shall be adequate to withstand all pressures to which the structures or trench will be subjected. Any movements or bulging which may occur shall be corrected so as to provide the necessary clearances and dimensions.
- B Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed. Where soil cannot be properly compacted to fill a void, lean concrete (Class III) shall be used as backfill at no additional expense to the Employer.
- C For purposes of preventing damage to structures, utilities or property, whether public or private, leave in place and embed in the backfill all sheeting and bracing as either directed in writing or agreed to by the Engineer. The Engineer may direct that sheeting and bracing be cut off at any specified elevation. Sheeting directed or agreed to by the Engineer to be left-

in-place shall be paid for at the unit rates listed in the Bill of Quantities. The Contractor shall not be paid extra costs for sheeting left-in-place which is driven below the springline of a pipe or that which is left-in-place to rectify a situation created by the Contractor's own acts or omissions nor for his convenience.

- D If, after the commencement of excavation, a risk situation develops for reasons not related to construction activities, the Engineer may direct that the sheeting be left-in-place. Such situations may include third party activities or conditions that could not have been reasonably foreseen by a prudent Contractor. Any instruction in this case will be issued in writing and payment will be made in accordance with the Bill of Quantities. Where, in the opinion of the Engineer, a risk situation occurs as a result of acts or omissions by the Contractor, no payment will be issued.
- E Subsequently, if the Contractor chooses to remove the sheeting, he must submit to the Engineer a written recommendation from the designer of the sheeting and bracing system prior to removing the sheeting. The designer shall visit the site, review the structural condition of the adjacent structures and make recommendations for proper removal techniques so as not to endanger the construction, other structures, utilities or property.
- F For all cases, authorization for payment for the sheeting left-in-place will be made only if the sheeting is within the "Zone of Influence" of the adjacent structures or utility. The zone of influence will be determined based on existing site conditions and shall be acceptable to the Engineer. In all cases of payment for sheeting left-in-place, the Contractor must obtain written authorization from the Engineer prior to backfilling the trench. Under no circumstances shall payment for sheeting left-in-place be made after the trench has been backfilled.
- G The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating any obligation on his part to issue such orders, and his failure to exercise his right to do so shall not relieve the Contractor from liability for injury to persons or damage to property occurring from or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place sufficient sheeting and bracing to prevent any caving or moving of the ground.
- H All timber sheeting installed to below the springline of an adjacent pipe shall be cut off and left in place below the level 300 mm above the pipe crown. The cost of this sheeting is construed to be included in the linear meter cost of the pipe.
- I All sheeting and bracing not left in place shall be carefully removed as the backfilling proceeds in such manner as not to endanger the construction or other structures, utilities, or property. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, or otherwise as may be directed.

3.05 TEST PITS

- A The Contractor may be required to excavate test pits for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.

- B Test pits shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as specified.

3.06 EXCAVATION BELOW GRADE AND REFILL

- A Whatever the nature of unstable material encountered or the groundwater conditions, trench drainage shall be complete and effective.
- B If the Contractor excavates below grade through error or for his own convenience, or through failure to properly dewater the trench, or disturbs the subgrade before dewatering is sufficiently complete, he may be directed by the Engineer to excavate below grade as set forth in the following paragraph, in which case the work of excavating below grade and furnishing and placing the refill shall be performed at his own expense.
- C If the material at the level of trench bottom consists of fine sand, sand and silt, or soft earth which may work into the crushed stone bedding notwithstanding effective drainage, the subgrade material shall be removed to the extent directed and the excavation refilled with a 150 mm layer of coarse sand, or a mixture graded from coarse sand to the fine peastone, as approved by the Engineer, to form a filter layer preserving the voids in the crushed stone bed of the pipe. The composition and gradation of the graded mixture shall be approved by the Engineer prior to placement. The graded mixture shall then be placed in 150 mm. layers thoroughly compacted up to the normal grade of the pipe. If directed by the Engineer, coarse aggregate shall be used for refill of excavation below grade.

3.07 BACKFILLING

- A As soon as practicable after the pipe has been laid and jointed, backfilling shall begin and thereafter be prosecuted expeditiously. Bedding material as specified for the type of pipe installed, shall be placed up to 0.3 meters over the pipe.
- B Where the pipes are laid “cross country” or in open fields, the remainder of the trench shall be filled with common fill material in layers not to exceed 0.30 meters and compacted to 95 percent maximum dry density in accordance with ASTM D698 and then mounded 0.15 m above the existing grade or as directed. Where a loam or gravel surface exists prior to cross country excavations, it shall be removed, conserved and replaced to the full original depth as part of the work under the pipe items. In some areas it may be necessary to remove excess material during the clean-up process, so that the ground may be restored to its original level and condition.
- C Where the pipes are laid in streets, the remainder of the trench up to a depth of 0.3 meters below the bottom of the specified permanent paving shall be backfilled with graded aggregate and thoroughly compacted to 95 percent density in accordance with ASTM D1557 in 150 mm layers.
- D The subbase layer for paving shall be select graded aggregate thoroughly compacted to 95 percent density in accordance with ASTM D1557 in 150 mm layers.

- E To prevent longitudinal movement of the pipe, dumping backfill material into the trench and then spreading will not be permitted until the specified bedding material for the specific type of pipe has been placed and compacted to a level 0.3 meters over the pipe.
- F Backfill shall be brought up evenly on all sides. Each layer of backfill material shall be thoroughly compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping, to the required compaction. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench.
- G All fill and backfill shall require moisture conditioning so that the moisture content is within 3 percent of the optimum moisture content at the time of compaction. It is the Contractor's responsibility that he obtain his own water for all moisture conditioning operations.
- H Where other methods are not practicable, compaction shall be by use of hand or pneumatic ramming with tools weighing at least 9 Kg. The material being spread and compacted in layers not over 150 mm thick. If necessary, sprinkling shall be employed in conjunction with rolling or ramming.
- I Backfill around pipeline structures shall be select backfill material. All backfill shall be compacted, especially under and over pipes connected to the structures, to 95% maximum dry density in accordance with ASTM D1557 in 150 mm layers.
- J Broken bituminous paving shall not be placed in backfilling.
- K All road surfaces shall be broomed and hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

3.08 RESTORING TRENCH SURFACE

- A Where the trench occurs adjacent to paved streets, in shoulders, sidewalks, or in cross-country areas, the Contractor shall thoroughly consolidate the backfill and shall maintain the surface as the work progresses. If settlement takes place, he shall immediately deposit additional fill to restore the level of the ground.
- B In and adjacent to streets, the top 300 mm layer of trench backfill shall consist of compacted select graded aggregate.
- C The surface of any driveway or any other area which is disturbed by the trench excavation and which is not a part of the paved road shall be restored by the Contractor to a condition at least equal to that existing before work began.

END OF SECTION

SECTION 02271

RIPRAP

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required to place riprap and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A Earthwork for Structures is included in Section 02200.
- B Trenching, Backfilling, and Compaction is included in Section 02222.

PART 2: PRODUCTS

2.01 MATERIALS

- A Riprap shall be hard, durable, angular in shape, resistant to weathering and may be naturally occurring particles or fragments of natural stone. Control of gradation shall be by visible inspection. Rounded stones, boulders, sandstone, or similar soft stone or relatively thin slabs will not be acceptable. Stone shall be free from overburden, spoil, shale and organic material. Each stone shall weigh not less than 20 kg nor more than 50 kg and at least 75 percent of the volume shall consist of stones weighing not less than 30 kg each. The remainder of the stones shall be so graded that when placed with the larger stones the entire mass will be compact.
- B A crushed stone base shall be placed and graded to a depth of 300 mm to obtain a continuous uninterrupted bed of the required thickness within the required limits.
- C Riprap shall be placed and graded off in a manner to ensure that the larger rock fragments are uniformly distributed and that the smaller rock fragments serve to fill the spaces between the larger rock fragments in a manner that will result in a compact mass of stone of the specified thickness. Hand placing will be required to the extent necessary to secure the results specified above.
- D Riprap shall have a minimum placed thickness of 30 cm with individual pieces at the surface having a maximum deviation of plus or minus 50 mm.
- E Placing of Riprap in layers or by dumping into chutes or by similar methods to cause segregation will not be permitted.

PART 3: EXECUTION

3.01 INSTALLATION

- A Place riprap to the limits and grades shown on the Drawings.
- B If the subbase for the riprap is deemed unsuitable by the Engineer replace the subbase with 300 mm of select backfill as specified in Section 02222. The select backfill shall be compacted to 95 percent dry density in accordance with ASTM D1557.

END OF SECTION

SECTION 02510

ROADWAY PAVEMENT

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, material, equipment and incidentals require to construct new asphaltic concrete roadways as shown on the Drawings.
- B Streets, driveways, curbing, parking areas, footpaths or sidewalk pavements damaged or disturbed by the Contractor's operations shall be repaired, replaced or restored in accordance with the requirements specified herein and as directed for respective type of pavement replacement and in a manner satisfactory to the Engineer. Replacement of sidewalks must match as closely as possible that which existed prior to construction.

1.02 RELATED WORK NOT INCLUDED

- A Site Preparation is included in Section 02100.
- B Earthwork for Structures is included in Section 02200.
- C Trenching, Backfilling and Compaction is included in Section 02222.

1.03 SUBMITTAL

- A Submit to the Engineer, in accordance with Section 01300, the following:
 - 1. Certified asphaltic concrete design mix
 - 2. Certified test results for gravel gradation.
- B Submittal and the Engineer's approval are required prior to the start of all pavement work.

1.04 REFERENCE SPECIFICATIONS

- A Except as otherwise specified herein, the current Specifications for Sewerage Works (1995) and for Water Mains and Distribution Systems and Appurtenances(1992) latest edition, issued by the Water Authority, Ministry of Water and Irrigation shall apply to materials and workmanship required for the Work of this Section.

PART 2: PRODUCTS

2.01 BASE COURSE

- A Material for road base course shall be obtained from approved borrow areas.
- B Imported road base course material shall consist of naturally occurring gravels, well graded, as approved by the Engineer. The maximum size of material shall not exceed 50 mm and not more than 15% shall pass the 200 sieve. The 4-day soaked CBR at 100% modified AASHO compaction shall be not less than 80%. The fine material passing the 200 sieve shall have a plasticity index not exceeding 10% and a liquid limit not exceeding 30%.

2.02 ASPHALTIC CONCRETE SURFACE COURSES

The materials used in asphaltic concrete base course, wearing course and binder course shall comply with the following:

- A Aggregate
 1. Course aggregate shall be hard, clean and durable crushed stone, crushed rock or crushed gravel from an approved source, with an Aggregate Crushing Value not more than 20%, shall be free from dirt and other deleterious material. Individual sizes of stone shall be combined from cold feed hoppers in suitable properties to achieve the following grading.

<u>Seive Size</u>	<u>Percentage by Weight Passing</u>
20 mm	100
14 mm	85 - 100
10 mm	0 - 100
6.3 mm	0 - 5

2. Fine aggregate shall consist of natural sand, sand prepared from stone, gravel or combinations thereof. It shall consist of hard, tough grains free from dirt and other deleterious material.

The grading of the fine aggregate shall comply with the following:

<u>Seive Size</u>	<u>Percentage by Weight Passing</u>
5 mm	100
2 mm	95 - 100
600 micron	75 - 100
212 micron	15 - 100
63 micron	0 - 3

3. Mineral filler shall consist of finely ground particles of hydrated lime, Portland Cement or other non-plastic mineral matter in accordance with ASTM D242 and approved by the Engineer. It shall contain no organic impurities and be free from foreign or other deleterious material, and shall meet the following grading.

<u>Seive Size</u>	<u>Percentage by Weight Passing</u>
600 micron	100
300 micron	95 - 10
75 micron	70 - 100

B Binder

The binder shall be 60/70 penetration straight run bitumen complying with AASHTO designation M20.

C Composition of Mix

- The aggregate shall be combined to give a grading curve between the following limits:

Base Course (Nominal max. Size 26.5 mm)

Aggregate Grading

<u>ASTM Seive Size</u>	<u>% Weight passing of total aggregate</u>
40 mm (1.5 in)	100
25 mm (1.0 in)	90 - 100
12 mm (0.5 in)	60 - 80
4.75 mm (#4)	25 - 60
2.36 mm (#8)	15 - 45
300 microns (# 50)	3 - 18
75 microns (# 200)	1 - 7

Wearing course and Single Course (Nominal max. size 19 mm)

Aggregate Grading

<u>ASTM Seive Aperture</u>	<u>% Weight passing of total aggregate</u>
25 mm (1.0 in)	100
20 mm (0.75 in)	90 - 100
9.5 mm (0.375 in)	60 - 80
4.75 mm (#4)	35 - 65
2.36 mm (#8)	20 - 50
300 microns (# 50)	3 - 20
75 microns (# 200)	2 - 8

- The nominal binder content shall be 3.5 % for the base course and 4.5% for the wearing course and single course, measured by weight of the total mix. The actual

binder content to be used will be determined by the Engineer following approval of the Contractor's mix design.

D Asphaltic Concrete Mix Design

The Contractor shall design the Asphaltic Concrete base course, wearing course mixes in accordance with the Asphalt Institute procedure. The mixers shall be designed to ensure that in production the material can maintain compliance with the Marshall limits given in paragraph E below, and such that the mixes are suitable for the use intended as road surfacing materials. The Contractor shall give adequate notice in writing of any additional information he requires to complete his design mix.

The Contractor shall submit to the Engineer for approval full details of his proposed aggregate grading and bitumen content together with details of the mix design.

When the design mix has been approved by the Engineer the Contractor shall maintain the mix properties as approved, within the following limits:

<u>% by Weight of</u>	<u>Total Mix</u>
Aggregate passing 5 mm sieve	+ or -3
Aggregate passing 1.18 mm sieve	+ or -2
Aggregate passing 63 micron	+ or - 1.5
Bitumen content	+ or - 0.2

E Marshall Mix Limits

The mixed materials in asphaltic concrete shall comply at all times with the following:

	<u>Base Course</u>	<u>Wearing Course Single Layer</u>
Compaction number of blows each end of specimen	50	50
Marshall Stability (kg)	400 - 1300	400 - 1500
Flow Value (mm)	2 - 4.5	2 - 4.5
Voids in mixed aggregates %	14 - 18	16 - 19
Voids in total mix %	3 - 8	3 - 5
Voids filled with bitumen %	57 - 83	69 - 85

PART 3: EXECUTION

3.01 INSTALLATION

A Laying and Compaction of Road Base Material

1. All material shall be placed and spread evenly.
2. Compaction of the base material shall be carried out as soon as possible after the

material has been laid. The material shall be compacted to 95% ASTM maximum density to a depth of 200 mm. Compaction shall be at moisture content between 1% above and below optimum. The compacted thickness of any layer shall not exceed 150 mm.

3. The finished surface shall be left smooth and to a camber or crossfall as shown on the drawings, and shall be clean, free from compaction cracks, ridges or loose material loose or otherwise defective material shall be dug out and made good with the new material to the required thickness and recompacted at the Contractor's expense.
4. Except where agreed by the Engineer, the completed base material must be protected from damage and must not be trafficked.
5. Smooth-wheeled and pneumatic tired rollers and vibratory compactors or power rammers where employed for compacting soils and pavement materials shall be of type with compacting effort approved by the Engineer and shall be capable of achieving the specified degree of compaction. The distribution of the wheels of rollers shall be such that the whole of the ground surface within the width of the roller is loaded during each pass of the roller.
6. After the subgrade has been prepared and has been approved by the Engineer, it shall be brought to the final grade and contour, thoroughly compacted and a prime coat applied.
7. The paved surface shall be sloped as shown on the Drawings.

B Laying of Asphaltic Concrete Courses

1. Provide at least one person who shall be thoroughly trained and experienced in the skills required, who shall be completely familiar with the design and application of work described for this Section and who shall be present at all times during progress of the work of Section and direct all work performed under this section.
2. For actual finishing of bituminous concrete surfaces and operation of the required equipment, use only personnel thoroughly trained and experienced in the skills required.
3. Asphaltic Concrete material shall be prepared in an approved central mixing plant of weight-batching type and shall be transported in clean vehicles, covered over while in transit or awaiting tipping. The use of dust, coated dust, oil or water on the interior of the vehicles to facilitate discharge of the mixed materials is permissible, but the amount shall be kept to a minimum and any excess shall be removed by tipping or brushing.
4. The mixed material shall as soon as possible after arrival at the Site be supplied continuously to the paver without delay. The rate of delivery of material to the paver shall be so regulated as to enable the paver to be operated continuously and it shall be so operated whenever practicable. The materials shall be spread by approved mechanical asphalt pavers and compacted by rollers approved by the Engineer.

5. The rate of travel of the paver and its method of operation shall be adjusted to ensure an even and uniform flow of material across the full laying width, freedom from dragging or tearing of the material, and segregation.
6. The material shall be laid in conformity with the recommendations for laying in the Asphalt Institute.
7. Hand laying of any bituminous material will be permitted only in the following circumstances.
 - (a) for laying regulating courses of irregular shape and varying thickness;
 - (b) in confined spaces where it is impracticable for a paver to operate;
 - (c) for footways.
8. Material shall be compacted as soon as possible as rolling can be effected without causing undue displacement of the mixed material and while this has a minimum rolling temperature applicable. The material shall be uniformly compacted by an 8 to 10 ton smooth wheeled roller having a width not less than 450 mm or by a multi-wheeled pneumatic tired roller of equivalent mass except that base course, wearing course and single course material shall be finished with a smooth wheeled roller.
9. The material shall be rolled in a longitudinal direction from the sides to the center of the roadway, overlapping on successive passes by at least half the width of the roller or in the case of a pneumatic-tired roller, at least the nominal width of one tire.
10. Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby.
11. Hand raking of wearing course material which has been laid by a paver and the addition of such material by hand spreading to the paved area for adjustment of level will be permitted only in the following circumstances.
 - (a) at the edges of the layers of material and at gullies and manholes;
 - (b) where otherwise directed by the Engineer.
12. Hand laid work shall conform to all the specification requirements of this clause except those relating to the manner of operating pavers.
13. Where joints between laying widths or transverse joints have to be made in the wearing course, the material shall be fully compacted and the joint made flush in one of the following ways. Method © shall always be used for transverse joints where applicable:
 - (a) by heating the joint with an approved joint heater at the time when the additional width is being laid but without cutting back or coating with

binder. The heater shall heat the full depth of the wearing course to a figure within rolling temperature range specified for the material and for a width not less than 75 mm on each side of the joint. In this case however, the Contractor shall be available for use in the event of breakdown, equipment necessary for operating method (c);

- (b) by using two or more pavers operating in echelon where this is practicable and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling; or by using a multiple-lane-width paver;
 - (c) by cutting back the exposed joints to a vertical face of not less than the specified thickness, discharge all loosened material and coating the vertical face completely with a grade of hot tar or hot bitumen suitable for the purpose before the next width is laid.
14. Maximum temperature during mixing shall not exceed 170 degrees Centigrade and laying the temperature shall be in the range 120-160 degrees Centigrade.
 15. The density of the completed asphaltic concrete layers shall be not less than 98% of the laboratory density of the approved Marshall mix design.
 16. All joints shall be offset at least 300 mm, from parallel joints in the layer beneath as indicated on the drawings.
 17. On completion of the wearing course, the edges shall be cut back to a vertical face to the dimensions as shown on the drawings.
 18. The levels of pavement courses shall be determined from the true finished road. Surface calculated from the vertical profile and crossfall as shown on the Drawings, vertical depth below the true pavement surface of any point on the formation or pavement courses shall be within the appropriate tolerance stated in the table below.

Tolerances in Surface Levels of
Pavement Courses and the Formation

Road Surface	+ or - 6 mm
Basecourse	+ or - 6 mm
Road Base	+ or - 15 mm
Formation	+ or - 20 mm

19. The surface regularity shall be tested where necessary, at points decided by the Engineer, with a straight edge 3 meters long placed parallel with or at right angles to the center line of the road. The maximum allowable deviation of the surface below the straight edge shall be:

For Road Surface	3 mm
For Basecourse Surface	6 mm
For Road Base	10 mm

20. Where any tolerances in this clause are exceeded, the Contractor shall determine the full extent of the area which is out of tolerance and make good the surface of the pavement course or formation in the manner described below.
- (a) If the surface is too high it shall be retrimmed and recompact to Specification. If the surface is too low the deficiency shall be corrected by scarification and the addition of suitable material of the same classification and moisture content or other approved material laid and compacted to Specification.
 - (b) If the road base is to incorrect levels the top 75 mm shall be scarified, reshaped with material added or removed as necessary, and recompact all to Specification. The area treated shall not be less than 10 meters long by 2 meters wide or such area determined by the Engineer as necessary to obtain compliance with the Specification.
 - (c) If the base course, wearing course and single layer are laid to incorrect levels they shall have the full depth of the layer removed and replaced with fresh material laid and compacted in compliance with the Specifications. The area rectified shall be the full width of the paving laid in one operation, and at least 5 meters long if basecourse or 15 meters if wearing course. Testing of the wearing course for compliance shall be carried out as soon as practicable after completion of the surfacing and remedial works shall be completed before the road is opened to traffic.

C Make-up of Roads

1. Any fill used as a sub-grade should comprise inert, granular, well-graded soils having a maximum particle size of 75 millimeters and containing less than 20 percent by weight of material passing No. 200 sieve. The plasticity index (PI) of the fill should be less than 6 percent.
2. The 300 mm thick road base material shall be placed in layers between 75 mm and 150 mm in thickness, placed on the subbase which shall have been compacted to not less than 95% of the maximum dry density, obtained in accordance with ASTM D1557. Base material should conform to ASTM D2940.
3. The two layer bituminous concrete shall comprise a 60 mm base course.
4. Prior to placing the base course, the road base shall be thoroughly dry and cleaned by mechanical brushes of all organic and loose material immediately prior to placing the prime coat, applied at a rate of not less than 0.5 kg/m².
5. If the base course is used by traffic or is in any other way dirtied prior to the wearing course, a tack coat, heated to between 25 deg. C and 60 deg. C, sprayed onto the base course at a rate of between 0.75 and 1 kg/m².

3.02 ROAD REINSTATEMENT

- A The top 300 mm of the pipe trench shall be filled, watered and compacted with approved road base materials. The filling and compaction shall be carried out in uniform layers not more than 150 mm thick and compacted to not less than 95% of maximum dry density according to ASTM D1557. Field density tests shall be conducted at locations and to the extent as directed by the Engineer, but not less than one test for every 100 linear meters of pavement to be reinstated for each layer of the road base.
- B At the top of the base, the width at the trench shall be increased 150 mm on each side, the Contractor shall use such methods, either drilling or chipping as will assure the breaking of the pavement along straight lines. The face of the remaining pavement shall be approximately vertical.
- C The Contractor shall use asphalt saw for cutting to assure sharp edges on the existing pavement end of the trench. All cracked and disturbed asphalt falling in the resurfaced width (trench + 2 x 150 mm) shall be removed without disturbing the created sharp edge.
- D After cleaning, the top of the base should be sprayed with asphalt (M.C. 70) at the rate of 1.5 - 2.0 kg/sq.m. Afterwards fine sand should be sprayed over the surface and left for two days.
- E After cleaning, the surface should be treated with asphalt tack coat RC-250 at the rate of 0.5 kg/sq.m. A layer of hot bituminous concrete plant mix shall, thereafter, be placed, rolled and compacted to 80 mm thickness. Asphalt tests should be taken at least every 500 linear meters of pavement to be resurfaced. Flow, stability and degree of compaction of asphalt should meet the specifications of the Ministry of Public Works.
- F The reinstatement of asphalted, tiled sidewalks, or concrete paths shall be carried out as specified in Clause 3.02-A. The base shall be furnished with concrete class III, 100 mm layer thick, finished with sand asphalt 50 mm layer thick for asphalted sidewalks or with tiles set in cement-mortar 1:3 for tiled sidewalks, or nothing over the new concrete layer for concrete paths (or concrete lanes, concrete passages and concrete sidewalks). If any concrete paths (or lanes, passages or sidewalks) have an existing concrete layer more than 100 mm thick, then the new concrete layer shall be as the existing concrete layer thickness over the base.

3.03 ROADWAY PAINTING

- A Parking lines shall be painted on the roadways and parking areas as shown on the Drawings.
- B Painting requirements are included in specification, section 09902.

3.04 CONSTRUCTION SEQUENCE

- A All pavement work shall be done after the completion of all major civil and site works to protect the newly constructed pavement.
- B The Contractor shall submit a pavement schedule to the Engineer for approval prior to the start of any pavement work.

END OF SECTION

SECTION 02516
CONCRETE UNIT PAVERS

PART 1: GENERAL

1.01 SCOPE OF WORK

Furnish all labor, material, equipment and incidentals required to install concrete unit pavers and curbs as shown on the Drawings and as specified herein.

1.02 SUBMITTALS

A In addition to product data, submit the following:

1. Samples showing the full range of colors, textures and patterns available for each type of unit paver and curbs indicated.
2. Include similar samples of material for joints and accessories involving color selection.

1.03 MOCKUPS

A Construct mockups for each form and pattern of unit paver and curbs. Locate mockups on-site in the location and of the size indicated or, if not indicated, as directed by Engineer.

1.04 WEATHER PROTECTION

A Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.

1. Install bituminous setting bed only when atmospheric temperature is above 40 degrees F (4 degrees C) and when base is dry.
2. Cold-Weather Requirements: Heat materials to provide mortar and grout temperatures between 40 degrees F (4 degrees C) and 120 degrees F (49 degrees C). Protect completed portions of work from freezing for 24 hours after installation.

B Hot-Weather Protection: Protect unit paver work to prevent excessive evaporation of setting beds and grout.

PART 2: PRODUCTS

2.01 MATERIALS

- A Colors and Textures: Natural finish or, as selected by Engineer from manufacturer's full range of colors and textures.
- B Concrete Pavers: Solid, 400 x 400 x 40 mm paving units, ASTM C936, made from normal-weight aggregates in sizes and shapes indicated.
- C Precast concrete curb mounted type, Size 120/150x300x500mm.
- D Aggregate Setting-Bed Materials: As follows:
 - 1. Graded Aggregate for Sub-Base: Washed gravel or washed crushed stone complying with ASTM C33 for Size No. 8 for coarse aggregate.
- E Mortar and Grout Mixes: Comply with referenced standards and with manufacturers' instructions. Discard mortars and grout when they have reached their initial set.
 - 1. Cement-Paste Slush Coat: Mix slush coat to a consistency similar to that of thick cream and consisting of either neat cement and water or cement, sand and water.
 - 2. Portland Cement/Lime Setting-Bed Mortar: ASTM C270, Proportion Specification, Type M.

PART 3: EXECUTION

3.01 INSTALLATION

- A Mix pavers from several pallets or cubes as they are placed to produce uniform blend of colors and textures.
- B Set unit pavers in pattern indicated with joint widths as indicated. Cut with motor-driven masonry saw to neatly fit adjoining work.
 - 1. For concrete pavers, a block splitter may be used.
- C Tolerances: Do not exceed 1/16-in (1.5-mm) unit-to-unit offset from flush (lippage) nor 1/8-in in 24-in (3-mm in 600-mm) and 1/4-in in 10-ft (6-mm in 3-m) from level, or indicated slope.
- D Expansion and Control Joints: Provide cork-filled joints at locations and of widths as directed. Install before setting pavers.
- F Aggregate Setting-Bed Paver Applications: Install as follows:
 - 1. Compact subgrade to 95 percent of ASTM D1557 laboratory density. Proof-roll prepared subgrade and provide additional compaction until deficient subgrades have been corrected.
 - 2. Place aggregate sub-base in thicknesses indicated. Compact by tamping with plate vibrator.
 - 3. Place cement mortar bed to thickness indicated.

4. Set pavers with a minimum joint width of 1/16-in (1.5-mm) and a maximum of 1/8-in (3-mm).
5. Tamp and beat pavers to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Do not realign surfaces or adjust joints after initial set of mortar.
6. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining pavers and other surfaces. After initial set of grout, finish joints by tooling slightly concave.
7. Cure grout by maintaining in a damp condition for 7 days except as otherwise recommended by latex additive manufacturer.

G Precast concrete curb stone: Install as follows:

- 1 Excavation for the position of the curb.
2. Place Concrete base
3. Place cement mortar bed to thickness indicated
4. Set curb stone with a minimum joint width of 1/16-in (1.5-mm) and a maximum of 1/8-in (3-mm).
5. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining pavers and other surfaces. After initial set of grout, finish joints by tooling slightly concave.
6. Cure grout by maintaining in a damp condition for 7 days except as otherwise recommended by latex additive manufacturer.

END OF SECTION

SECTION 02575

PAVEMENT REPAIR AND RESURFACING

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, material, equipment and incidentals require to replace all pavement surfaces, tiled sidewalks, concrete pathways and curbing removed over trenches or otherwise disturbed by the Contractor's operations.
- B Streets, driveways, curbing, parking areas, footpaths or sidewalk pavements damaged or disturbed by the Contractor's operations shall be repaired, replaced or restored in accordance with the requirements specified herein and as directed for respective type of pavement replacement and in a manner satisfactory to the Engineer. Replacement of sidewalks must match as closely as possible that which existed prior to construction.
- C Resurfacing works shall be conducted soon after completing the trench backfilling. In general after trench backfilling no more than 250 m of unreinstated pavement will be permitted at any construction site.

1.02 RELATED WORK NOT INCLUDED

- A Trenching, Backfilling and Compacting is included in Section 02222.
- B Roadway Pavement is included is included in Section 02510.

1.03 SUBMITTAL

- A Certificates shall be submitted from the bituminous concrete manufacturer showing the grading and characteristics of the bituminous concrete design mixes.

1.04 REFERENCE SPECIFICATIONS

- A Except as otherwise specified herein, the current Specifications for Sewerage Works (1995) and for Water Mains and Distribution Systems and Appurtenances (1992) latest edition, issued by the Water Authority, Ministry of Water and Irrigation shall apply to materials and workmanship required for the Work of this Section.

PART 2: PRODUCTS

2.01 MATERIALS

- A Bituminous concrete shall be composed of coarse and fine aggregate, an aggregate filler and an asphalt cement. The asphalt cement shall conform to ASTM D946 and have a penetration grade of 85-100.

- B The quantity of asphalt cement shall be between 4 and 6% for the base course and between 5 and 7% for the wearing course. The exact quantity of asphalt cement shall be determined according to the aggregate grading and the Marshall Test specified in ASTM D1559 in which a Stability Index of at least 725 kg shall be achieved.
- C Asphalt primer shall be medium curing type conforming to AASHTO M82 type M.C. 70.
- D Tack coat shall be Grade RC-250 emulsified asphalt conforming for AASHTO M81.
- E The coarse and fine aggregate shall conform to ASTM D3515, have similar chemical properties and be clean, hard and sound, and free from decomposed stone, organic matter, shale, clay lumps and other deleterious matter.
- F The aggregate filler shall conform to ASTM D242, be limestone dust, cement or other inter materials and be graded as follows:

sieve size mm -----	Percent Passing -----
600 um* (No. 30)	100
150 um (No. 100)	85 - 100
75 um (No. 200)	65 - 100

*um = micrometers

- E The coarse aggregate shall be crushed limestone or other crushed rock acceptable to the Engineer and shall all be retained on AASHTO 2.0 m (No. 10) sieve. It shall exclude flat or elongated pieces and shall adhere to asphalt cement to meet the AASHO Stripping Test No. T - 182. The loss by abrasion shall not be more than 40% for the base course material and not more than 35% for the wearing course material as determined by the AASHTO Abrasion Test No. T-96.
- H The fine aggregate shall be sand or other material acceptable to the Engineer and shall all pass an AASHTO 2.0 mm (No. 10) sieve.
- I The combined aggregate grading shall be as follows:

Sieve Designation	HEAVY TRAFFIC		MEDIUM/LIGHT TRAFFIC	
	Binder Course	Wearing Course	Binder Course	Wearing Course
1 1/2"	-	-	-	-
"1" (25.0 mm)	100 70-	100	100 70 -	100
3/4" (19.0 mm)	100-53-90	90-100 71 -	100 53-90	90-100 71 -
1/2" (12.5 mm)	40-80-30 56	90 56-80 35-	40-80 30- 56	90 56-80 35-
3/8" (9.5 mm)	23-38 13 -	56 23- 38	23-49 14 -	65 23- 49
No. 4 (4.75 mm)	27	13- 27 5 -	43	14- 43 5 -

No. 8 (2.36 mm)	5 - 17	17	5 - 19	19
No. 20(1.18 mm)	4 - 14	4 - 14	4 - 15	4 - 15
No. 50(0.300mm)	2 - 8	2 - 8	2 - 8	2 - 8
No. 80(0.150mm)				
No.200(0.075mm)				

J Aggregate Courses for roadways, base course will have the following gradation (when tested in accordance with ASTM C 136):

sieve size mm	percent passing by weight
-----	-----
37.5	100
25.0	60-100
19.0	55-85
4.75	35-60
2.00	25-50
0.425	15-30
0.075	8-15

2.02 Testing

All laboratory testing shall be performed in accordance with the referenced ASTM standard. All testing shall be conducted at an independent laboratory in accordance with Specifications Section 01410.

PART 3: EXECUTION

3.01 ROAD REINSTATEMENT

- A The top 300 mm of the pipe trench shall be filled, watered and compacted with approved road base materials. The filling and compaction shall be carried out in uniform layers not more than 150 mm thick and compacted to not less than 95% of maximum dry density according to Modified Proctor Test. Field density tests shall be conducted at locations and to the extent as directed by the Engineer, but not less than one test for every 100 linear meters of pavement to be reinstated for each layer of the road base.
- B At the top of the base, the width at the trench shall be increased 150 mm on each side, the Contractor shall use such methods, either drilling or chipping as will assure the breaking of the pavement along straight lines. The face of the remaining pavement shall be approximately vertical.
- C The Contractor shall use asphalt saw for cutting to assure sharp edge on the existing pavement end of the trench. All cracked and disturbed asphalt falling in the resurfaced width (trench + 2x150) shall be removed without disturbing the created sharp edge.
- D After cleaning, the top of the base should be sprayed with asphalt (M.C. 70) at the rate of 1.5 - 2.0 kg/sq.m. Afterwards fine sand shall be spread over the surface and left for two days.

- E. After cleaning, the surface should be treated with asphalt tack coat RC-250 at the rate of 0.5 kg/sq.m. A layer of hot bituminous concrete plant mix shall, thereafter, be placed, rolled and compacted to 80 mm thickness. Asphalt tests should be taken at least every 500 linear meters pavement to be resurfaced. Flow, stability and degree of compaction of asphalt should meet the specifications of the Ministry of Public Works and Housing.
- F The trench shall be prepared as stated above for road reinstatement of asphalt, tiled sidewalks, or concrete paths. The base shall be topped with concrete Class III, 100mm layer thick, finished with a sand asphalt 50mm layer thick for asphalted side walks or with tiles set in cement-mortar 1:3 tiled sidewalks, or with no additional surface treatment over the new concrete layer for concrete paths (or concrete lanes, concrete passages and concrete sidewalks). If any concrete paths (or lanes, passages or sidewalks) have an existing concrete layer more than 100mm thick, then the new concrete layer shall be as the existing concrete layer thickness over the base.

END OF SECTION

SECTION 02616

BURIED DUCTILE IRON PIPE AND FITTINGS

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required, install, test, and disinfect ductile iron pipe and fittings for transmission pipeline and its take offs and its connections to existing pipelines as shown on the Drawings and as specified herein.
- B Piping shall be located substantially as shown on the Drawings. The interface point between Division 02 piping and Division 15 piping shall be at station 0+000 of the Pipeline (at the end of the Zatory new pump station discharge header) The Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference between pipes or for other reasons. Pipe fitting notation is for the Contractor's convenience and does not relieve him from installing and jointing different or additional items where required to achieve a complete piping system.
- C Where the word "pipe" is used it shall refer to pipe, fittings, or appurtenances unless otherwise noted.

1.02 RELATED WORK

- A Trenching, Backfilling and Compaction is included in Section 02222.
- B Mechanical steel pipe and fittings is included in Section 15061.

1.03 SUBMITTALS

- A Shop drawings and product data shall be submitted in accordance with Section 01300 for Engineer's review.

1.04 REFERENCE STANDARDS

- A American Society for Testing and Materials (ASTM)
 - 1. ASTM A307 - Standard Specification Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - 2. ASTM A716 - Specification for Ductile Iron Culvert Pipe.
 - 3. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.
 - 4. ASTM C150 - Standard Specification for Portland Cement.

B American National Standards Institute (ANSI) / American Water Works Association (AWWA)

1. ANSI/AWWA C104/A21.4 - ANSI Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. ANSI/AWWA C105/A21.5 - ANSI Standard for Polyethylene Encasement for Ductile-Iron Piping for Water.
3. ANSI/AWWA C110/A21.10 - ANSI Standard for Ductile-Iron and Gray-Iron Fittings, 3-in Through 48-in for Water.
4. ANSI/AWWA C111/A21.11 - ANSI Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
5. ANSI/AWWA C150/A21.50 - ANSI Standard for the Thickness Design of Ductile-Iron Pipe.
6. ANSI/AWWA C151/A21.51 - ANSI Standard for Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water.
7. ANSI/AWWA C600 - ANSI Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

C American Water Works Association (AWWA)

1. AWWA C651 - Disinfection of Water Mains.

D International Standards

1. ISO 2531, ISO 4179, ISO 8179, and ISO 4633

E Where reference is made to one of the above standards, the latest version in effect at the time of bid opening shall apply. Where the above standards conflict or overlap, the more stringent will apply or that in the opinion of the Engineer is in the best interests of the Owner.

1.05 QUALITY ASSURANCE

A All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with these Specifications by an independent testing laboratory as specified in Section 01410.

B Inspection of the pipe and fittings will also be made by the Engineer or representative of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specified requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.

Up to 3 samples may be taken by the engineer to be tested at the RSS for compliance with the specifications; the contractor will be responsible for the cost of testing

C All pipe and fittings shall be permanently marked with the following information:

1. Manufacturer, date.
2. Size, type, class, or wall thickness.
3. Standard produced to (ANSI/AWWA, ASTM, ISO, etc).

1.06 DELIVERY, STORAGE AND HANDLING

- A Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe. Under no circumstances shall the pipes be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be used in pipe handling.
- B Materials, if stored, shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.
- C Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Pipe in tiers shall be alternated. At least two rows of (100 mm) by (100 mm) timbers shall be placed between tiers and chocks affixed to each end in order to prevent movement.
- D Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

PART 2: PRODUCTS

2.01 MATERIALS

A Pipe

1. Ductile iron pipe shall be wall thickness Class 51, minimum.
2. Pipe shall be supplied in standard lengths.
3. Ductile iron pipe shall conform to ISO 2531, K9, bell and spigot pipe or ANSI/AWWA C151/A21.51
4. Ductile iron pipe shall conform to all aspects of the specifications. Examples of such pipe are as manufactured by American, US Pipe, or approved equal.

B Joints

1. Ductile iron pipe shall have rubber-gasket push-on joint. Rubber-gasket joints shall be ethylene propylene and conform to ANSI/AWWA C111/A21.11, or ISO 2531.

2. Pipe line length with restrained joints shall be suitable for the test pressure and shall utilize a retainer ring which does not restrict the deflection of the joint, with the standard mechanical joints. Bolts and nuts shall conform to ASTM A307, Grade B. Rubber gasket shall be as specified above. Premium type restrained joints as manufactured by the pipe supplier or manufacturer may be used subject to the Engineer's approval.

C Fittings

Ductile iron pipe fittings shall meet the requirements of ISO 2531 K12 for all fitting and K14 for all tees or ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 as applicable.

D Interior Lining

All pipe and fittings shall be cement mortar lined and seal coated in accordance with ISO 4179 or ANSI/AWWA C104/A21.4. The cement shall be Type II for water applications and Type V for wastewater applications per ASTM C150 and shall be centrifugally spun with a uniform thickness of not less than 3.2 mm. Fittings shall also have an epoxy or bituminous interior lining in accordance with ISO standards.

E Exterior Coatings

1. In accordance with ISO 2531, all ductile iron pipe shall have an external metallic zinc coating in accordance with ISO 8179.
2. All pipe and fittings shall have a bituminous outside coating in accordance with ANSI/AWWA C151 and C110 respectively.
3. Buried pipe shall be installed with polyethylene encasement conforming to ANSI/AWWA C105/A21.5. The polyethylene sheet shall be 8 mils thick minimum, Class C, black.
4. Buried restrained joints and sleeve-type couplings shall have a protective wrapping of "Denso" material as manufactured by DENSO Inc. of Texas, or approved equal. Where "Denso" material is used, the joint shall be packed up with "Densyl mastic" to give an even contour for wrapping with "Densopol" tape. A 1.5 mm thick coating of "Denso" paste shall be applied followed by 100 mm or more wide "Densopol" tape wound spirally round the joint with at least 50 percent overlap.

PART 3: EXECUTION

3.01 LAYING UNDERGROUND DUCTILE IRON PIPE

- A Ductile iron pipe and fittings shall be installed in accordance with requirements of ANSI/AWWA C600, except as otherwise specified or shown on the Drawings.

- B Pipe trench details shall be as shown on the Drawings and/or as specified. Bedding and backfill materials shall be as specified in Section 02222. Bedding and backfill materials shall be placed to fully support the pipe. Blocking will not be permitted.
- C Pipe shall be sound and clean before laying. Good alignment and profile shall be preserved to conform to the plan and profile as shown on the Drawings. Joint assembly shall be in accordance with procedures recommended by the pipe manufacturer. Pipe ends shall be plugged when pipe laying is not in progress for any length of time.
- D Fittings, in addition to those shown on the Drawings, shall be provided when required by the site utility conditions. When cutting of pipe is required, the cutting shall be done by abrasive saw. Any damage to the lining shall be repaired to the satisfaction of the Engineer. Cut ends of pipe shall be beveled to conform to the manufactured spigot end.
- E Wherever ductile iron pipe passes from concrete to earth horizontally, two flexible couplings and/or mechanical joints spaced from 0.6 - 1.2 m apart shall be installed, with the first joint within 0.6 m of the exterior face of the wall, whether or not shown on the Drawings. The coupling and/or joint adjacent to the concrete shall be a dielectric insulating coupling or joint as detailed on the Drawings.
- F Restrained joint or suitable tie-rods shall be provided where there is a possibility of pulling the joint under pressure. Concrete anchors and thrust blocking shall be provided where there are thrust forces resulting from change of pipe direction or diameter (reducers) in either horizontal or vertical planes. Thrust block bearing area against the soil shall be as shown on the Drawings.

3.02 TESTING

- A After installation, the pipe shall be tested for compliance with the Specifications. Furnish all necessary equipment and labor for the pressure test and leakage test on the pipelines.
- B Submit detailed test procedures and method for Engineer's review. In general, testing shall be conducted in accordance with ANSI/AWWA C600.
- C Pressure pipelines shall be subjected to a hydrostatic pressure 1.5 times the nominal pressure of the pipe. This test pressure shall be maintained for a minimum of two hours. The leakage rate shall not exceed those indicated in ANSI/AWWA C600.
- D Gravity pipelines shall be subjected to hydrostatic pressure test as specified in ANSI/AWWA C600.

3.03 CLEANING

- A At the conclusion of the work, the Contractor shall thoroughly clean all of the pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. All debris shall be removed from the pipeline. The lowest segment outlet shall be flushed last to assure debris removal

3.04 DISINFECTION

- A Ductile iron pipe used for potable water service, including well collector lines, shall be disinfected after cleaning. Provide all necessary equipment and labor for the disinfection.
- B Disinfection shall be in accordance with AWWA C651.
- C An acceptable disinfection procedure may be as follows:

1. All water main pipe, fittings, valves and appurtenances shall be disinfected by the Contractor as specified herein unless otherwise directed by the Engineer's Representative. All necessary apparatus, water and chlorine required for disinfection shall be furnished by the Contractor at no additional expense to the Owner.
2. The Contractor shall, during the initial filling of the pipeline, simultaneously introduce a continuous feed of chlorine at the same point where the pipeline is being filled. The rate of filling the pipeline and the feed rate of the chlorine shall be proportioned so that the initial concentration of the chlorine in the pipeline is between 50 and 100 milligrams per liter. To assure that this concentration is maintained, the chlorine residual shall be measured at blow-offs, air release valves, or other locations during the filling operation.
3. The following is the amount of chlorine required, using either liquid chlorine (gas at atmospheric pressure) or a one percent chlorine solution, to produce a 100 milligram per liter concentration in 100 meters of pipe for the various diameters of pipe:

Nominal Pipe Diameter (mm)	100 Percent Liquid Chlorine (kg)	1 Percent Chlorine Solution (liters)
600	2.97	297
400	1.30	130
300	0.75	75
250	0.51	51
200	0.33	33
150	0.18	18
125	0.13	13
100	0.08	8
80	0.05	5
65	0.04	4

4. The use of liquid chlorine will only be permitted when suitable equipment consisting of a solution feed chlorinator together with a booster pump for injecting the chlorine gas-water mixture into the pipeline to be disinfected is used. Introduction of chlorine gas directly from the supply cylinder will not be allowed.
5. The Contractor shall submit a detailed description of the procedure he proposes to use to disinfect the pipelines, including a description of all equipment to be used, for the Engineer's Representative's approval prior to starting the disinfection operations.

6. The chlorinated water shall remain in each section of pipeline for at least 24 hours and during this period all valves and blow-offs shall be operated in order to disinfect these appurtenances. At the end of the 24-hour period, the water in the pipeline shall contain no less than 25 milligrams per liter of chlorine throughout the entire length of pipe. The Contractor shall repeat the operation at no additional cost to the Owner as necessary to provide complete disinfection.
7. All pipelines shall be flushed by the Contractor after all hydrostatic pressure tests and disinfection operations have been performed and accepted by the Engineer's Representative. However, it is the responsibility of the Contractor to prevent all dirt and foreign matter from entering the pipeline and for cleaning each length of pipe and all fittings, valves and appurtenances of sand, dirt and foreign matter during the installation. All necessary apparatus and water required for flushing shall be furnished by the Contractor.

END OF SECTION

SECTION 02617

BURIED STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, material, tools, equipment and incidentals required and install and test steel pipe and fittings, rubber gaskets, mortar for inside joints and wrap outside joints of all pipe as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A. Trenching, backfilling and compaction is included in Section 02200.
- B. Sand materials for pipe embedment are included in Section 02200.
- C. Pavement repair and replacement is included in Section 02575.

1.03 SUBMITTALS

- A. Submit, in accordance with Section 01300, within 30 days of the Effective Date of the Agreement, the name of the pipe and fittings suppliers and a list of materials to be furnished.
 - B. Submit shop drawings with a tabulated layout schedule showing the location of each piece, by mark number, for the entire job, method of manufacture and installation of pipe, joint details, fittings and any specials. Design calculations for the conditions specified in Paragraph 1.03D below, shall be submitted with the shop drawings and shall include all formulas used in the calculations, all values of constants used in the formulas in accordance with AWWA C200 and AWWA M11 based on internal pressure, deflection and external loads.
 - C. Prior to shipment of pipe, submit certified test reports that the pipe for the Contract was manufactured and tested in accordance with the AWWA standards specified herein.
- D. Design Data
- 1. Pipe and fittings shall be designed in accordance with AWWA C200 and C208, using the following design conditions:

- a. External Loads

- 1) Weight of earth 2100 Kg/m³

- 2) Deflection Lag Factor 1.25
- 3) Bedding Constant (k) 0.10
- 4) Soil Modulus E' 70 Kg/cm²
- 5) Live Load
 - a) Pipe in Streets AASHTO H-20 for two trucks passing Coopers E-80
- 6) Internal Pressure
 - a) Design Pressure
6 Bar for the 1200 mm and 600 mm suction piping
24 Bar for the 400 mm and 1000 mm discharge piping
 - b) Water Hammer plus design pressure
NEED THIS FROM RON
 - c) Field Test Pressure
9 Bar for the suction piping
36 Bar for the discharge piping
 - d) Minimum wall thickness mm
9.5 mm for 1200 mm suction header
6.4 mm for the 600 mm suction piping
12.7 mm for the 400 mm discharge piping
19.1 mm for the 1000 mm discharge header

2. Pipe and fittings shall be designed with a maximum deflection of the steel cylinder of 2 percent of the internal diameter.
3. The wall thickness shall be increased, as required, at all bends, fittings and anchorage locations where thrust is transmitted by the pipe.

1.04 REFERENCE STANDARD

- A. American Society for Testing and Materials (ASTM)

1. ASTM A139 - Standard Specification for Electric-Fusion (Arc) - Welded Steel Pipe (NPS 4-in and over).
 2. ASTM A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 3. ASTM A570 - Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
 4. ASTM A572 - Standard Specification for High-Strength Low-Alloy Columbium -Vanadium Structural Steel.
 5. ASTM C150 - Standard Specification for Portland Cement.
- B. American Water Works Association (AWWA)
1. AWWA C200 - Steel Water Pipe - 6-in (150mm) and Larger
 2. AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4-in and Larger - Shop Applied.
 3. AWWA C206 - Field Welding of Steel Water Pipe.
 4. AWWA C207 - Steel Pipe Flanges for Waterworks Service-Sizes 4-in Through 144-in (100mm Through 3600mm).
 5. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings.
 6. AWWA C209 - Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
 7. AWWA C214 - Tape Coating Systems for the Exterior of Steel Water Pipelines.
 8. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 9. AWWA C606 - Grooved and Shouldered Joints
 10. AWWA C651 - Disinfecting of Water Mains
 11. AWWA M11 - Steel Pipe - A Guide for Design and Installation.
- C. American National Standards Institute (ANSI)
1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
 2. ANSI B16.5 - Pipe Flanges and Flanged Fittings.

- D. American Welding Society (AWS)
- E. American Society of Mechanical Engineers (ASME)
- F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. The manufacturer is responsible for the performance of all inspection requirements as specified in AWWA C200. In addition, all pipe and fittings to be installed under this Contract may be inspected at the plant by the Engineer for compliance with this Section by an independent testing laboratory selected by the Owner. Specifically require the manufacturer to perform the following:
 - 1. Have pipe and fittings made sufficiently in advance so that a minimum of 50-ft of 60-in pipe, 150-ft of 48-in pipe and six assorted fittings will be approved at each plant inspection. Pay for each inspection visit that does not result in these minimum amounts being approved, the cost being deducted from monthly progress payments.
 - 2. Notify the independent testing laboratory at least 48 hours prior to requesting inspections.
- B. Inspection of the pipe and fittings will also be made by the Engineer or other representatives of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.
- C. All pipe and fittings shall be hydrostatically tested at the plant to 50 percent above the normal operating pressure as defined in Paragraph 1.03D above. If the fittings are made from hydrostatically tested pipe then only dye testing of the welds is required.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Steel pipe shall be fabricated from steel sheets in accordance with AWWA C200, Section 3. The steel sheets shall conform to ASTM A570, Grade 36 plates conforming to ASTM A283 Grade C or D, or ASTM A572, Grade 42 or coil conforming to the requirements of ASTM A139, Grades B or C. All welded seams, whether straight or spiral, shall be butt welded using an approved electric-fusion weld process. Design stress shall be limited to 50 percent of the yield or 15000 psi whichever is less.

- B. Fittings and specials shall be fabricated in accordance with AWWA C200, Section 4, including non-destructive testing by dye penetrant of welds not previously tested in the straight pipe. Fittings shall conform to the dimensions of AWWA C208 or may be fabricated into standard pipe lengths. Elbows 0 to 22-1/2 degrees shall be two pieces, 23 to 45 degrees shall be three pieces, 46 to 67-1/2 degrees shall be four pieces and 68 to 90 degrees shall be five pieces. All tees, laterals and outlets shall be reinforced in accordance with ASME Pressure Vessel Code, Section VIII Paragraph UG-37 or AWWA M11, Section 19.4 and 19.5. Fittings and specials not detailed on the Drawings shall conform to the details furnished by the manufacturer as approved by the Engineer. All fittings shall be manufactured at factory, shop manufactured fittings will not be acceptable.
- C. Flanges shall be in accordance with AWWA C207, Class D, Table 1 or 2 for pressure to 175 psi on 4 to 12-in diameter and 150 psi on diameters over 12-in. Flanges shall be AWWA C207, Class E for pressures over 150 through 275 psi when mating steel to steel; or shall be ANSI B16.5, Class 300 flat faced for 24-in and smaller diameter or Class 250 flat faced with dimensions and drilling conforming to ANSI B16.1 for diameters over 24 through 48-in when mating to cast iron valves.
- D. Pipe shall be furnished principally in 40-ft net laying lengths with special lengths as required by plan and profile for location of elbows, tees, etc. Pipe shall be furnished with O-ring joints unless otherwise noted on the Drawings.
- E. O-ring joints shall consist of a Carnegie shape M-3516 joint ring for spigot end or flared bell end and a grooved spigot end designed to retain the O-ring rubber gasket. The spigot end groove may be rolled in. Bell and spigot ends shall be sized by forcing over a sizing die or by expanding to stretch the steel beyond its elastic limit so that the difference in diameter between outside of spigot and inside of bell at normal engagement does not exceed .03-in measured on the circumference with a diameter tape. The bell and spigot with flared bell and grooved spigot end shall have 6-3/8-in engagement. The O-ring gasket shall have sufficient volume to approximately fill the area of the groove and shall conform to AWWA C200. The joint shall be suitable for a safe working pressure equal to the class of pipe furnished and shall operate satisfactorily with a deflection (the tangent of which is not to exceed 0.75-in divided by D where D is the outside diameter of the pipe in inches) or with a pull-out of 0.75-in.
- F. O-ring joints shall be electrically bonded using bonding wire and brazing cartridges furnished by the pipe manufacturer. Be responsible for checking the continuity of this system before final acceptance.
- G. Mechanical couplings where indicated on the Drawings shall be Victaulic Depend-O-Lok Styles E x E (unrestrained), F x F (self-restrained); Dresser Style 38 or equal. Middle ring shall be of a thickness equal to or greater than the thickness of pipe wall. Couplings shall have plain gaskets, Grade 27 and shall be shop coated with Dresser Red "D" or primer compatible with the tape coat system. Dresser couplings shall be furnished complete with bonding wire and brazing cartridges.

- H. Interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement mortar lining applied centrifugally in conformity with AWWA C205. Wire mesh reinforcement shall be used in guniting mortar lining of fittings and specials.
- I. Cement shall be Type II and shall be in accordance with ASTM C150.
- J. Non-shrink grout employed in the interior joints shall be Masterflow 713 grout by Master Builders or equal.
- K. Pipe shall be coated and wrapped outside with "Pre-Fabricated Multilayer Cold Applied Polyethylene Tape Coating" in accordance with AWWA C214. The total thickness of coating shall be 80 mils consisting of: primer, 20 mil inner layer for corrosion protection and two 30 mil outer layers for mechanical protection.
 - 1. Shop applied outside coating shall be continuous to the end of pipe on the bell end and shall be cut back on spigot end so that coating extends at least 0.5-in inside of the bell end at normal engagement. Shop applied inside lining shall be continuous to the end of pipe on the spigot end and shall be cut back on the bell end to the point of maximum engagement or further as shown on Drawings. Inside of bell and outside of spigot shall be painted with one shop coat of primer (Polyken No. 927 or equal).
 - 2. Prior to shipment, the pipe shall be given an electrical holiday test of a minimum of 6000 Volts with a 60 cycle current audio detector giving a maximum testing voltage 120 times per second. Prior to placement, the pipe shall be visually inspected for damage to the coating. Any areas that appear damaged shall be given an electrical holiday test of a minimum of 6000 Volts with a 60 cycle current audio test giving a maximum testing voltage 120 times per second. If the tests indicate no holidays and the outer wrap is wrinkled but not torn, no repairs are required. If the tests indicate no holidays and the outer wrap(s) is torn, the damaged layer or layers of the outer wrap shall be removed by carefully cutting with a sharp razor-type utility knife. The area to be patched shall be washed with xylol taking care to wash a minimum of 4-in of undamaged tape where the hand applied tape wrap will overlap. Cold applied tape (outer wrap) meeting the requirements of AWWA C209 and compatible with the tape wrapping system shall then be applied for each layer of white tape that has been removed.
 - 3. When the damaged area shows a holiday when tested, the white outer layers shall be removed and the black inner wrap, Polyken No. 989-20 exposed. The exposed area and overlaps shall then be primed with a light coat of 927 primer. A patch of inner wrap of sufficient size to extend 4-in from the holidays in all directions shall then be firmly pressed into place. The patch shall then be holiday tested to determine that it is satisfactory. The outer layer of white tape shall then be retrimmed to expose the first wrap of white tape sufficiently to allow a minimum lap of 2-in in all directions. The exposed white tape shall then be washed with xylol and primed. Two layers of outer wrap with a minimum thickness of 35 mils and conforming to AWWA C209 shall then be applied.

- L. Restrained joints where required at changes in direction or shown on the Drawings shall be single or double welded lap joints. Design of the joint and welds shall include considerations of stresses induced in the steel wall, the joints, and any field welds, caused by thrust at bulkheads, bends, reducers, and line valves resulting from the working and/or transient pressure. For field welded joints, design stresses shall not exceed 50 percent of specified minimum yield strength of the grade of steel utilized for the part being examined when longitudinal thrust is assumed to be uniformly distributed around the circumference of the joint. Where harnesses are required for sleeve-type couplings, they shall be in accordance with the requirements of AWWA M11. Pipe ends for mechanical couplings shall conform to AWWA C200 Section 3.6 and in accordance with manufacturers' recommendations. The shop applied outside coating shall be held back as required for field assembly of the mechanical coupling or to harness lugs and rings. Harness lugs or rings and pipe ends shall be painted with one shop coat of primer compatible with exterior coating and field joint coating materials. The inside lining shall be continuous to the end of the pipe.
- M. The manufacturer shall supply pipe complete with sufficient struts to maintain the pipe in a round condition and to limit its deflection during storage and transportation to the job site.
- N. The manufacturer shall supply any insulated adapter where the pipeline is connected to existing prestressed concrete cylinder pipe.

PART 3 EXECUTION

3.01 HANDLING PIPE AND FITTINGS

- A. Pipe shall be transported from the coating plant to the jobsite on padded bunks with nylon tie-down straps or padded banding to adequately protect the pipe and coating.
- B. Coated pipe shall be handled, stored and shipped in a manner that will prevent damage to the coating. Pipe shall be handled with wide belt slings or rubber padded forklifts. Chains, cables or other equipment likely to cause damage to the pipe or coating shall not be used.
- C. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen will be permitted to walk upon the coating only when necessary, in which case they shall wear shoes with rubber or composition soles and heels. All pipe and fittings, specials and couplings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the Engineer.
- D. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his/her own expense.
- E. Stored pipe shall at all times be supported on sawdust bags, sand bags, or other suitable support. Bags shall be of sufficient size to prevent contact of the pipe coating with the ground or any other obstruction. Rolling the pipe on the coated surface will not be permitted.

3.02 LAYING STEEL PIPE AND FITTINGS

- A. Regulate the equipment and construction operations such that the loading of the pipe does not exceed the loads for which the pipe is designed and manufactured.
- B. Except as otherwise specified herein, pipe and fittings shall be installed in accordance with the requirements of AWWA M11.
- C. Struts are to be left in the pipe until backfill is complete.
- D. Permit and aid in the inspection of the coating on the underside of the pipe at the time of installation and shall repair any damage before lowering the pipe into the trench. While being laid, the pipe shall not be rolled, skidded, or otherwise moved, when it contacts with the ground at any point.
- E. The method of jointing the pipe shall be in strict accordance with the manufacturer's instructions. Arrange for the manufacturer to supervise the installation of at least the first three standard joints and the first restrained joint. Pipe shall be laid with bell ends upstream, unless otherwise approved by the Engineer.
- F. As soon as the excavation is completed to the bottom of the excavation, place sand fill in the trench. The pipe shall then be firmly bedded in this gravel to conform to the line and grade indicated on the Drawings. The sand fill shall be placed and compacted as specified in Section 02200 to a point 1-ft above the top of the pipe. Blocking under the pipe will not be permitted.
- G. Sand fill shall be compacted to give complete vertical and lateral support of the pipe. A depression shall be left in the supporting gravel at the joint to prevent contamination of the rubber gasket immediately before being forced home. Before the pipe is lowered into the trench, the bell and spigot shall be cleaned and free from dirt. Gasket and bell shall be lubricated with a vegetable lubricant furnished by the manufacturer. The lubricant shall not be soluble in water, and shall be harmless to the rubber gasket. As soon as the spigot is centered in the bell of the previously laid pipe, it shall be forced home with jacks or come-alongs, if used. After the pipe is brought fully home, the gasket shall be carefully checked for proper position around the full circumference of the joint. The jacks or come-alongs (if used) shall be anchored sufficiently back along the pipeline so that the pulling force will not dislodge the pieces of pipe already in place.
- H. As soon as the pipe is in place and before the come-along (if used) is released, sand fill shall be placed to the top of the pipe for at least one half the length of the pipe. Not until this backfill is placed shall the jacks or come-along (if used) be released. If any motion at joints can be detected, a greater amount of backfill shall be placed before pressure is released.
- I. O-ring joints shall be electrically bonded using bonding wire and brazing cartridges furnished by the pipe manufacturer.

- J. Field joints shall be wrapped in accordance with AWWA C209. The joints shall be cleaned, primed and wrapped with two wraps of tape with a 35 mil thickness each and holiday tested.
- K. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline shall be repaired and holiday tested as acceptable to the Engineer.
- L. The interior joints of pipe 30-in in diameter and larger shall be filled with non-shrink grout after backfilling is completed. Non-shrink grout shall be employed. Prior to application the entire joint shall be wetted and the interior concrete mortar allowed to absorb the moisture. A curing agent as recommended by the grout manufacturer shall also be employed subsequent to grout application.
- M. All pipe shall be sound and clean before laying. When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved in laying. The deflections at joints shall not exceed that recommended by the manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided.
- N. Have on hand a sufficient supply of assorted short pipe lengths, adaptors and any other fittings necessary to prevent delays in pipe laying.
- O. Restrained joints shall be installed to the limits indicated on the Drawings or as directed by the Engineer in accordance with applicable provisions of the above. Restraining shall be by harnessed Dresser or field welded.

3.03 FIELD WELDING

- A. All field welding shall be in accordance with the AWS. Welding for restrained joints shall be a full fillet weld for the entire circumference in accordance with AWWA C206.
- B. During welding the coating shall be protected by draping an 18-in wide strip of heat resistant material over the top half of the pipe on each side of the coating holdback to avoid damage to the coating by hot weld splatter. No welding ground shall be made on the coated part of the pipe.

3.04 CONNECTIONS TO STRUCTURES

- A. Wherever a pipe 3-in in diameter or larger passes from concrete to earth horizontally, a minimum of two flexible joints spaced from 2 to 4-ft apart depending on pipe size shall be installed within 2-ft of the exterior face of the wall, whether or not shown on the Drawings. Acceptable flexible joints shall be Victaulic Depend-O-Lok F x F Modified or equal.
- B. Wall pipes shall have a thrust collar located at mid-depth of wall.
- C. Piping underneath structures shall be concrete encased.

3.05 CLEANING

- A. At the conclusion of the laying, and prior to testing, thoroughly clean all of the new pipelines by spraying with water or other means to remove all dirt, stones, wood struts, pieces of wood or other material which may have entered during the construction period. Debris cleaned from the lines shall be removed at construction access manholes or access ports. If, after this cleaning, obstructions remain, they shall be removed.
- B. After the pipelines are cleaned and if the groundwater level is above the pipe, or following a heavy rain, the Engineer will examine the pipe for leaks. If defective pipes or joints are discovered at this time, they shall be repaired or replaced.

3.06 TESTING

- A. Electrical Continuity
 - 1. Furnish all necessary equipment and labor for carrying out a continuity check of the pipeline. This check shall be conducted prior to introduction of water into the pipeline for hydrostatic pressure and leakage testing.
- B. Furnish all necessary equipment and labor for carrying out Hydrostatic Pressure and Leakage Tests on the pipeline in accordance with applicable provisions of AWWA C600.
- C. Pressure Test
 - 1. All pipelines shall be tested by subjecting each section to a pressure, measured at the lowest end of the section, of at least 150 percent of the class rating or design pressure of pipe under test (see Paragraph 1.03D above).
 - 2. The test may be made before or after backfilling. However, if mechanical compaction is to be used in the backfilling operations as spelled out in AWWA C600, the test shall not be made until the backfilling is completed and compacted. All connections, blowoffs, hydrants, and valves shall be tested with the main as far as is practicable.
 - 3. The test section shall be slowly filled with potable water, and all air shall be vented from the line. The rate of filling shall be as acceptable to the Engineer, with at least 24 hour notice required before tests are scheduled. While the test section is under test pressure, a visual inspection for leaks shall be made along the pipeline, and all visible leaks repaired. The pressure test shall not begin until the pipe has been filled with water for at least 24 hours to allow for absorption in the cement mortar lining.
- D. Leakage Test
 - 1. Leakage test shall be made after pressure test has been satisfactorily completed and all backfilling and compaction is completed to top of trench. Furnish the necessary apparatus and assistance to conduct the test.

2. To pass the leakage test, the leakage from the pipeline shall not exceed the leakage allowed by the following formula:

$$L = \frac{ND \sqrt{P}}{3700}$$

in which

L = allowable leakage in gallons per hour.

N = number of joints in the pipeline being tested, this "N" being the standard joint length of the pipe furnished divided into the length being tested, with no allowance for joints at branches, blowoff, fittings, etc.

D = nominal diameter of pipe in inches.

P = average observed test pressure of the pipe being tested, equal to at least 100 percent of the class rating of pipe being tested, in pounds per square inch gauge, based on the elevation of the lowest point in the line or section under test and corrected to the elevation of the test gage.

3. Should the test on any section of the pipeline show leakage greater than specified above, locate and repair the defective pipe, fittings, or joint until the leakage is within the specified allowance of two hour duration. All repairs and retests, if required, shall be made at no additional cost to the Owner.

3.07 CHLORINATION OF PIPELINES

- A. Chlorination of the pipelines used for potable water shall be as specified in Section 02616.

END OF SECTION

SECTION 02640

BURIED VALVES AND APPURTENANCES

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required to provide all buried valves, valves in manholes and underground vaults and appurtenances complete with actuators and all accessories as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A Trenching, Backfilling and Compaction are included in Section 02222.
- B Buried Ductile Iron Pipe and Fittings are included in Section 02616.
- C Concrete is included in Division 3.

1.03 SUBMITTAL

- A Submit to the Engineer, in accordance with Section 01300, shop drawings and product data required to establish compliance with the Specifications. Submittals shall include at least the following:

1. Manufacturer's literature, illustrations, specifications and engineering data including:
 - a. Dimensions.
 - b. Size.
 - c. Materials of construction.
 - d. Weight.
 - e. Protection coating.
 - f. Nominal Pressure

- B Test Reports

1. Four copies of all certified shop test results specified herein.

- C Operation and Maintenance Manuals

1. Complete operating and maintenance instructions shall be furnished for all valves and actuators included under this section as provided in Section 01730.

D Certificates

1. Certificates of compliance where required by referenced standards: For each valve specified to be manufactured and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests, and certification of proper installation.

1.04 REFERENCE STANDARDS

A Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

B American Water Works Association (AWWA)

1. AWWA C500 - Gate Valves, 3-in Through 48-in NPS, for Water and Sewage Systems.
2. AWWA C509 - Resilient-Seated Gate Valves, 3-in Through 12-in NPS, for Water and Sewage Systems.

C American National Standards Institute (ANSI)

1. ANSI B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
2. ANSI C111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.

D American Society for Testing and Materials (ASTM)

1. ASTM A48 - Gray Iron Castings.
2. ASTM A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings
3. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4. ASTM A276 - Standard Specification for Stainless and Heat Resisting Steel Bars and Shapes.
5. ASTM A536 - Ductile Iron Castings.

E British Standards

1. BS 5153 - for check valves
2. BS 1952 - for gunmetal gate valves
3. BS 1010 - for gunmetal stop valves

F Steel Structures Painting Council (SSPC)

1. SSPC SP-6 - Commercial Blast Cleaning

- G Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A Manufacturer's Qualifications

1. Valves and appurtenances provided under this Section shall be the standard product in regular production by manufacturers whose products have proven reliable in similar service for at least five years. If required, the manufacturer shall furnish evidence of at least ten recent installations in satisfactory operation.
2. All units of the same type shall be the product of one manufacturer.

B Design Criteria

1. All valves and appurtenances shall be new and in perfect working condition. Valves shall be designed for continuous use with a minimum of maintenance and service required and shall perform the required function without exceeding the safe limits for stress, strain or vibration. In no case will used or damaged valves be acceptable. The selection of valves and appurtenances to meet the specified design conditions is the responsibility of the Contractor. Both workmanship and material shall be of the very best quality and shall be entirely suitable for the service conditions specified.

C Source Quality Control

1. Valves shall be shop tested in accordance with the following:
 - a. Gate valves: AWWA C500.
2. Obtain each type of valve from the same manufacturer.

1.06 DELIVERY, STORAGE AND HANDLING

A Deliver materials to the site to ensure uninterrupted progress of the work.

B Protect threads and seats from corrosion and damage. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until time of use.

C Provide covers for all openings.

1. All valves 75 mm and larger shall be shipped and stored on site until time of use with wood or plywood covers (box) on each valve end.
2. All valves smaller than 75 mm shall be shipped and stored as above except that heavy card board covers (box) may be furnished instead of wood.

D Store equipment to permit easy access for inspection and identification. Any corrosion in evidence at the time of Owner walk-through acceptance shall be removed, or the valve shall be removed from the job.

- E Store all equipment in covered storage off the ground.

1.07 COORDINATION

- A Review installation procedures under other Sections and coordinate with the work which is related to this Section including buried piping installation and site utilities.
- B Contractor shall coordinate the location and placement of concrete thrust blocks or restrained joints when required.

PART 2: PRODUCTS

2.01 GENERAL

- A All buried valves shall open counter clockwise.
- B The use of a manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- C Valves shall be of the size shown on the Drawings or as noted, and as far as possible equipment of the same type shall be identical and from one manufacturer.
- D Valves shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard to which they are manufactured cast in raised letters on some appropriate part of the body.
- E Unless otherwise noted, valves shall have the same nominal pressure as the pipe they connect to.
- F Valves shall be of the same nominal diameter as the pipe or fittings they are connected to. Except as otherwise noted, joints shall be flanged or mechanical joints, with joint restraint where the adjacent piping is required to be restrained.

2.02 GATE VALVES

- A Gate valves 75 mm diameter and smaller shall have flanged, screwed, or solder ends as required and shall be brass, or bronze, or Type 304 stainless steel solid wedge, union bonnet, rising-stem gate valves. Equipment supplied shall conform to all aspects of the specification. Examples of such equipment are as manufactured by Jenkins Brothers; Crane; Fairbanks; Kennedy Valve Manufacturing Co.; Lukenhiemer, or approved equal.
- B For gate valves 80 mm or larger, these general requirements apply.
 1. Gate valves shall meet the equivalent requirements of AWWA C500 and AWWA C509 as applicable to the type of valve specified.
 2. Buried and submerged valves shall be furnished with mechanical joints and stainless steel hardware non-rising stem design.

3. Valves shall be furnished with ISO-2531 flanged ends rated for the PN as specified on the drawings.
4. All-metal valves shall be manufactured of ASTM A126 Cast Iron, Class B, with bronze mounting design.
5. Rising stem valves shall be sealed with adjustable and replaceable packing; valve design must permit packing replacement under operating system pressures with only moderate leakage.
6. All valve bodies shall be hydrostatically tested to at least twice the rated working water pressure. In addition, valves shall be seat-tested, bi-directional at the rated working pressure, with seat leakage not to exceed one fluid ounce per inch of valve diameter per hour. Provide certificates of testing.
7. All bonnet and packing gland bolts shall be zinc or cadmium electroplated steel; packing gland bolts shall have bronze nuts.
8. All valves shall be marked per what Standards, including name of manufacturer, valve size and working pressure and year of manufacture.
9. Unless otherwise indicated, valves 300 mm and smaller shall be capable of installation in the vertical or horizontal position, sealing in both directions at the rated pressure.
10. Valve operation shall be counterclockwise. Provide permanent label showing "OPEN" and arrows.
11. Metal-seated valves shall be coated internally and externally with an asphaltic varnish, per AWWA C500. Resilient seated valves shall be coated, interior and exterior with fusion bonded epoxy per AWWA C550.

C Valve Styles

1. Double disc design shall conform to all aspects of the specifications. Examples of such equipment are manufactured by American-Darling Valve; Kennedy Valve; M&H Valve Company, or approved equal.
2. Double revolving disc shall conform to all aspects of the specifications. Examples of such equipment are manufactured by American-Darling Valve, or approved equal.
4. Double Disc Design Requirements
 - a. Conform to AWWA C500 or equivalent ISO standard.
 - b. Wedging surfaces shall be bronze, monel or stainless steel.
5. Double Revolving Disc Design Requirements
 - a. Conform to applicable provisions of AWWA C500 or equivalent ISO standard.

- b. Wedging surfaces shall be monel or stainless steel.
- c. Discs fully free to rotate, guided in travel by cast surfaces.
- d. Disc rotation shall produce a self-cleaning action during opening or closing.
- e. Wedging forces applied only when discs are in seating position.

2.03 BUTTERFLY VALVES

- A. Valves shall be manufactured in strict accordance with AWWA C504. Valves shall be bubble tight at rated pressures. Valve discs shall rotate 90 degrees from full closed to open. Operators shall be assembled to the valve by the valve manufacturer. The valve/operator shall be tested as a complete assembly by the valve manufacturer. The manufacturer shall have produced AWWA butterfly valves for a minimum of 5 years.
- B. Valve bodies shall be constructed of cast iron ASTM A126, Class B. Valves in vaults shall be flanged. Flange drilling shall be in accordance with ANSI B16.1, Class 150. Laying length shall be short body as listed in AWWA C504. Buried valves shall be mechanical joint end conforming to ANSI C111.
- C. Valve discs shall be constructed of cast iron ASTM A126 or A48, ductile iron ASTM A536. Disc edge shall be either ni-chrome or Type 316 stainless steel.
- D. Rubber valve seats shall be Buna-N. The seat shall be located in the valve body. If seat retaining hardware such as screws and segments are used they shall be monel. If screws are used, monel plugs shall be affixed in the valve body and tapped to receive these screws.
- E. Valve shafts shall be Type 304 stainless steel, ASTM A276 and shall be of a diameter not less than those listed in AWWA C504, Class 150B.
- F. Shaft seals shall be furnished where the shaft projects thru the valve body. Shaft seals shall be standard split-v type packing.
- G. Valves shall be fitted with sleeve type bearings contained in the trunions of the valve body. Bearing material shall be nylon for valves thru 20-in and fiberglass with teflon lining for valves 24-in and larger.
- H. Valve manufacturer shall furnish and mount operator suitable for buried service. Operators shall be self-locking and suitable for submergence to 20-ft. A 2-in square operating nut shall be furnished. Operator stops shall be capable of withstanding an input of 450 ft-lbs.
- I. All valves shall be hydrostatically and leak tested.
- J. Valve class shall be AWWA Class 150B with operators sized for bi-directional flow.
- K. Valves shall be manufactured by Henry Pratt Company, Aurora, IL, DeZurik or approved equal.

2.04 SURFACE PREPARATION AND SHOP COATINGS

- A The interior ferrous metal surfaces, except finished or bearing surfaces, shall be blast cleaned in accordance with SSPC SP-6, or approved equal, and painted with two coats of an approved two-component coal tar epoxy coating specifically formulated for potable water use based on the current edition of the United States Environmental Protection Agency's list entitled "Accepted Categories and Subcategories of Coatings, Liners and Paints for Potable Water Usage."
- B Exterior ferrous metal surfaces of all buried valves and hydrants shall be blast cleaned in accordance with SSPC SP-6, or approved equal, and given two shop coats of a heavy coal tar enamel or an approved two-component coal tar epoxy paint.

PART 3: EXECUTION

3.01 INSPECTION AND PREPARATION

- A During installation of all valves and appurtenances, the Contractor shall verify that all items are clean, free of defects in material and workmanship and function properly.
- B All valves shall be closed and kept closed until otherwise directed by the Engineer.
- C All valves shall be installed in accordance with the manufacturer's recommendations.

3.02 VALVE ASSEMBLIES

Where shown on the Drawings, specified or directed, air release valves, gate valves, butterfly valves, various valves and assemblies, including pressure relief valves, and washouts assemblies shall be installed. A dismantling joint shall be provided with each valve assembly to allow servicing of the valve. The particular types and construction details of each valve assembly are shown on the Drawings.

Chambers shall be provided with manhole frames and cover(heavy duty type) of the size and opening indicated on the Drawings. Manhole rungs (cast iron) shall be provided. Precast concrete leveling rings shall be used to adjust the manhole cover to the proper grade. Chambers shall be equipped with ventilation pipe of the size and configuration shown on the Drawings.

3.03 AIR RELEASE ASSEMBLY

Where indicated on the Drawings or directed by the Engineer, the Contractor shall install air release assembly in a chamber based on the size of the water main. Details for the construction of the air release assembly are shown on the Drawings.

3.04 WASHOUT ASSEMBLY

Where indicated on the Drawings or directed by the Engineer, the Contractor shall install washout assemblies on the various sizes of water mains. Details for construction of the washout assemblies are shown on the Drawings.

The length of pipe beyond the gate valve shall be extended to such a length to assure that the blowoff discharge water will neither flood nor cause any damage to surrounding property or facilities.

The washout discharge shall end at a headwall, unless otherwise directed by the Engineer. The discharge shall not be connected to a sanitary sewer. The discharge shall be located above flood level.

3.05 FIELD TESTS AND ADJUSTMENTS

Conduct a functional field test of each valve and assembly, including actuators and valve control equipment, in presence of Engineer to demonstrate that each part and all components together function correctly. All testing equipment required shall be provided by the Contractor.

END OF SECTION

SECTION 02901

MISCELLANEOUS WORK

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required to do the miscellaneous work specified in this Section.
- B When no applicable specification exists the Contractor shall perform the work in accordance with the best modern practice and/or as directed by the Engineer.
- C The work of this Section includes, but is not limited to, the following:
 - 1. Cleaning up.
 - 2. Job photographs.
 - 3. Restoring easement and right-of-ways.
 - 4. Temporary facilities.

PART 2: PRODUCTS

2.01 MATERIALS

- A Materials required for this Section shall be the same quality of materials that are to be restored. Where possible and with Engineer's approval, the Contractor may re-use existing materials that are removed.

PART 3: EXECUTION

3.01 CLEANING UP

- A The Contractor shall remove all construction material, excess excavation, buildings, equipment and other debris remaining on the job as a result of construction operations and shall restore the site of the work to a neat and orderly condition.

3.02 PHOTOGRAPHS OF PROJECT

- A Prior to the excavation in any street or cross country area, the Contractor shall document existing conditions using construction photographs as detailed in Section 01300. In critical areas, such as adjacent to structures or other physical features, the Contractor may be required to video-tape the existing conditions in the Engineer's presence in addition to providing the required photographs.

- B The photographs shall be retained in a secure location by the Contractor throughout the duration of the project and shall then be turned over to the Owner.

3.03 RESTORING EASEMENTS AND RIGHT-OF-WAYS

- A The work under this item shall include all protection and restoration of private property required within the limits of the easements. All protection and restoration required outside the easement limits shall be at the Contractor's own expense. All protection and restoration required within the trench limits shall be paid for under the pipe items in the Bid Form.
- B The Contractor shall be responsible for all damage and shall restore all easement areas and affected private property to its original condition as existed prior to construction. He shall protect from injury all walls, ledges, fences, cultivated shrubbery and vegetables, fruit trees, pavement, underground facilities, such as water pipe, or other utilities which may be encountered along the route. If removal and replacement are required, it shall be done in a workmanlike manner so that replacement is equivalent to that which existed prior to construction.
- C Lawn and grass surfaces, if any, damaged by construction shall be replaced. The Contractor shall cut and replace the lawn and sod, or he may restore the areas with an equivalent depth and quality of loam, seed and fertilizer as necessary to produce a stand of grass at least equal to that existing prior to construction. These areas shall be maintained and reseeded, if necessary, until all work under this Contract has been completed and accepted. Any additional work required to restore property to the original condition shall be performed by the Contractor.
- D Existing trees, shrubs, plants and bushes outside of easements that may be affected by the construction procedure shall be fully protected. When necessary, the work shall include removing and replacing those trees, shrubs and bushes. It shall include the careful excavation of the root ball which shall be wrapped with burlap while out of the ground. The Contractor shall replant them after backfilling the trench, stake them in an upright position and shall periodically water replanted trees, bushes and shrubs. The Contractor shall be fully responsible for ensuring that any and all trees, bushes and shrubs removed and replanted "take" and return to a viable state. Any replanted item that fails to "take" or that is so damaged as to be unsuitable for replanting shall be replaced by the Contractor, at no additional cost to the Owner, with a tree, bush or shrub equal to the one removed.
- E The Engineer will inspect all work for provisional acceptance upon the written request of the Contractor received at least ten days before the anticipated date of inspection.

After all necessary corrective work has been completed, the Engineer will certify in writing the provisional acceptance of the planting.

- F All plants shall be guaranteed by the Contractor for not less than one full year from the time of provisional acceptance.

At the end of this period, any plant that is missing, dead, or not in satisfactory growth, as determined by the Engineer, shall be replaced.

All replacements shall be plants of the same kind and size. They shall be furnished and planted as specified herein. The cost of replacement shall be borne by the Contractor except where it can be definitely shown that loss resulted from activities outside the Contractor's control such as vandalism.

At the end of the guarantee period, inspection will be made by the Engineer, to identify corrective work if any.

After all necessary corrective work has been completed and tree staking has been removed, the Engineer will certify in writing the final acceptance of the planting.

3.04 TEMPORARY FACILITIES

- A The Contractor shall furnish, install, maintain and remove all temporary facilities required for construction or called for in the specifications.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required and design, install and remove formwork for cast-in-place concrete as shown on the Drawings and as specified herein.
- B Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts and other items furnished under other Sections and required to be cast into concrete.

1.02 RELATED WORK

- A Concrete Reinforcement is included in Section 03200.
- B Concrete Joints and Joint Accessories are included in Section 03250.
- C Cast-in-Place Concrete is included in Section 03300.
- D Concrete Finishing is included in Section 03350
- E Grout is included in Section 03600.
- F Masonry is included in section 04200

1.03 SUBMITTALS

- A Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Form release agent
 - 2. Form ties
 - 3. Location and sequence of the concrete placements. Indicate locations of form joints, panel sizes and patterns. Show location of form ties on architectural surfaces.
 - 4. Review of pour sequence, form system and panel layout shall be for appearance and strength of the completed structure only. Approval by the Engineer of forming plans or procedures shall not relieve the Contractor of responsibility for the strength, safety or correctness of methods used, the adequacy of equipment, or from carrying out the work in full compliance with the requirements of the Drawings and as specified herein.

- B Samples: Demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not adversely affect concrete surfaces to be painted, coated or otherwise finished and will not affect the forming materials.
- C Certificates: Certify form release agent is suitable for use in contact with potable water after 30 days (non-toxic and free of taste and odor)

1.04 REFERENCE STANDARDS

- A American Concrete Institute (ACI)
 - 1. ACI 301 - Specifications for Structural Concrete for Buildings
 - 2. ACI 318 - Building Code Requirements for Reinforced Concrete
 - 3. ACI 347 - Formwork for Concrete
- B American Plywood Association (APA): Material grades and designations as specified
- C Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.06 SYSTEM DESCRIPTION

- A General: Architectural Concrete is wall, slab, beam or column concrete which will have surfaces exposed to view in the finished work. It includes similar exposed surfaces in water containment structures from the top of walls to 1000 mm below the normal water surface in open tanks and basins.
- B Structural design responsibility: All forms and shoring shall be designed and erected in accordance with the requirements of ACI 301 and ACI 318 and as recommended in ACI 347 and shall comply with all applicable regulations and codes. The design shall consider any special requirements due to the use of plasticized and/or retarded set concrete.

PART 2 PRODUCTS

2.01 GENERAL

The usage of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

2.02 MATERIALS

- A Forms for cast-in-place concrete shall be made of wood, metal, or other approved material. Wood forms for the project shall be new and unused, unless previously used forms can be shown to meet the requirements of reused forms as specified herein. Construct wood forms of sound lumber or plywood of suitable dimensions and free from knotholes and loose knots. Where used for exposed surfaces, dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Metal forms may be used when approved

by the Engineer and shall be of an appropriate type for the class of work involved. All forms shall be designed and constructed to provide a flat, uniform concrete surface requiring minimal finishing or repairs.

B Wall Forms

1. Forms for all exposed exterior and interior concrete walls shall be new and unused exterior grade plywood panels manufactured in compliance with the APA and bearing the trademark of that group, or equal acceptable to the Engineer. Provide B grade or better veneer on all faces to be placed against concrete during forming. The class of material and grades of interior plies shall be of sufficient strength and stiffness to provide a flat, uniform concrete surface requiring minimal finishing and no grinding.
2. All joints or gaps in forms shall be taped, gasketed, plugged, and/or caulked with an approved material so that the joint will remain watertight and will withstand placing pressures without bulging outward or creating surface patterns.
3. Forms for circular structures shall conform to the circular shape of the structure. Straight panels may be substituted for circular panels if the straight panels do not exceed 0.6 m in width nor deflect more than 3-1/2 degrees per joint, nor conflict with specific notes on the Drawings.

C Column Forms

1. Rectangular columns shall be formed as specified for wall forms. All corners shall have a 20 mm chamfer unless otherwise noted on the Drawings.
2. Circular columns shall be formed with steel, fiberglass reinforced plastic, or seamless cardboard column forms. The forms shall be continuous for the height of the column between construction joints indicated on the Drawings unless otherwise approved by the Engineer.

D Rustications shall be at the location and shall conform to the details shown on the Drawings. Moldings for chamfers and rustications shall be milled and planed smooth. Rustications and corner strips shall be of a nonabsorbent material, compatible with the form surface and fully sealed on all sides to prohibit the loss of paste or water between the two surfaces.

E Form Release Agent: Coat all forming surfaces in contact with concrete using an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise noted. Form release agents used in potable water containment structures shall be suitable for use in contact with potable water and shall be non-toxic and free of taste or odor.

F Concrete surfaces which are to be painted shall be formed with hard plastic finished plywood or a similar material which does not require a form release agent unless the Contractor can substantiate to the satisfaction of the Engineer that the form release agent will not remain on the formed surface after it is stripped.

G Forms for Architectural Concrete or Concrete Receiving Architectural Finish.

1. Forms for architectural concrete shall be constructed of materials and in a manner that will result in rigid forms with sufficient strength to withstand, without noticeable deflection, movement, or leakage, the high hydraulic pressures resulting from rapid filling of the forms and heavy high frequency vibration of the concrete. Deflection in formwork shall be limited to $1/360$ of each component span. Form joints shall be laid out in a uniform pattern or as indicated on the Drawings.
2. Form material for producing architectural finishes shall be constructed of steel, fiberglass reinforced plastic, or high density overlay plywood.

H Form Ties

1. Form ties encased in concrete other than those specified in the following paragraphs shall be designed so that, after removal of the projecting part, no metal shall remain within 38 mm of the face of the concrete. The part of the tie to be removed shall be at least 12 mm diameter or be provided with a wood or metal cone at least 12 mm diameter and 38 mm long. Form ties in concrete exposed to view shall be the cone-washer type.
2. Form ties for exposed exterior and interior walls shall be as specified in the preceding paragraph except that the cones shall be of approved wood or plastic.
3. Flat bar ties for panel forms shall have plastic or rubber inserts having a minimum depth of 38 mm and sufficient dimensions to permit proper patching of the tie hole.
4. Ties for liquid containment structures shall have an integral waterstop that is tightly welded to the tie.
5. Common wire shall not be used for form ties.
6. Alternate form ties consisting of tapered through-bolts at least 25 mm in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used at the Contractor's option. Obtain Engineer's acceptance of system and spacing of ties prior to ordering or purchase of forming. Clean, fill and seal form tie hole with non-shrink cement grout.

PART 3: EXECUTION

3.01 GENERAL

- A Forms shall be used for all cast-in-place concrete including sides of footings. The Contractor shall be responsible for watertightness of the form ties and any repairs needed. Forms shall be constructed and placed so that the resulting concrete will be of the shape, lines, dimensions and appearance indicated on the Drawings.
- B Forms for walls shall have removable panels at the bottom for cleaning, inspection and joint surface preparation. Forms for walls of considerable height shall have closable intermediate inspection ports. Tremies and hoppers for placing concrete shall be used to

allow concrete inspection, prevent segregation and prevent the accumulation of hardened concrete on the forms and reinforcement above the fresh concrete.

- C Molding, bevels, or other types of chamfer strips shall be placed to produce blockouts, rustications, or chamfers as shown on the Drawings or as specified herein. Chamfer strips shall be provided at horizontal and vertical projecting corners to produce a 20 mm chamfer. Rectangular or trapezoidal moldings shall be placed in locations requiring sealants where specified or shown on the Drawings. Sizes of moldings shall conform to the sealant manufacturer's recommendations.
- D Forms shall be sufficiently rigid to withstand construction loads and vibration and to prevent displacement or sagging between supports. Construct forms so that the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for the adequacy of the forming system.
- E Before form material is re-used, all surfaces to be in contact with concrete shall be thoroughly cleaned, all damaged places repaired, all projecting nails withdrawn and all protrusions smoothed. Reuse of wooden forms for other than rough finish will be permitted only if a "like new" condition of the form is maintained.

3.02 FORM TOLERANCES

- A Forms shall be surfaced, designed and constructed in accordance with the recommendations of ACI 347 and shall meet the following additional requirements for the specified finishes.
- B Formed Surface Exposed to View: Edges of all form panels in contact with concrete shall be flush within 1.0 mm and forms for plane surfaces shall be such that the concrete will be plane within 1.5 mm in 1.2 meters. Forms shall be tight to prevent the passage of mortar, water and grout. The maximum deviation of the finish wall surface at any point shall not exceed 6 mm from the intended surface as shown on the Drawings. Form panels shall be arranged symmetrically and in an orderly manner to minimize the number of seams.
- C Formed surfaces not exposed to view or buried shall meet requirements of Class "C" Surface in ACI 347.
- D Formed rough surfaces including mass concrete, pipe encasement, electrical duct encasement and other similar installations shall have no minimum requirements for surface smoothness and surface deflections. The overall dimensions of the concrete shall be plus or minus 25 mm.
- E Formed concrete Surfaces to Receive Paint: Surface deflections shall be limited to 1.0 mm at any point and the variation in wall deflection shall not exceed 1.5 mm per 1.2 meters. The maximum deviation of the finish wall surface at any point shall not exceed 6 mm from the intended surface as shown on the Drawings.
- F Architectural Concrete: All smooth faces to be exposed to view shall have surface deflections limited to 1.0 mm at any point and the variation in wall deflection shall not exceed 1.5 mm per 1.2 meters. The maximum deviation of the finished wall surface at any

point shall not exceed 6 mm from the intended surface as shown on the Drawings. All textured faces, form lines, or rustications to be exposed to view shall be straight, plumb and true with a variation of no more than 8 mm in 3 meters measured in any direction.

3.03 FORM PREPARATION

- A Wood forms in contact with the concrete shall be coated with an effective release agent prior to form installation.
- B Steel forms shall be thoroughly cleaned and mill scale and other ferrous deposits shall be sandblasted or otherwise removed from the contact surface for all forms, except those utilized for surfaces receiving a rough finish. All forms shall have the contact surfaces coated with a release agent.

3.04 REMOVAL OF FORMS

The Contractor shall be responsible for all damage resulting from removal of forms. Forms and shoring for structural slabs or beams shall remain in place in accordance with ACI 301 and ACI 347. Form removal shall conform to the requirements specified in Section 03300

3.05 INSPECTION

- A The Engineer shall be notified when the forms are complete and ready for inspection at least 6 hours prior to the proposed concrete placement.
- B Failure of the forms to comply with the requirements specified herein, or to produce concrete complying with requirements of this Section, shall be grounds for rejection of that portion of the concrete work. Rejected work shall be repaired or replaced as directed by the Engineer at no additional cost to the Owner. Such repair or replacement shall be subject to the requirements of this Section and approval of the Engineer.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1: PRODUCTS

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein.
- B Furnish all the deformed steel reinforcement required to be entirely built into the concrete masonry unit construction.

1.02 RELATED WORK

- A Concrete Formwork is included in Section 03100.
- B Concrete Joint and Joint Accessories are included in Section 03250.
- C Cast-in-place Concrete is included in Section 03300.
- D Grout is included in Section 03600.
- E Masonry is included in Section 04200.

1.03 SUBMITTALS

- A Submit shop drawings and product data, in accordance with Section 01300, showing materials of construction and details of installation for:
 - 1. Reinforcing steel: Placement drawings shall conform to the recommendations of ACI 315. All reinforcement in a concrete placement shall be included on a single placement drawing or cross referenced to the main pertinent placement drawing. This drawing shall include the additional reinforcement (around openings, at corners, etc.) shown on the standard detail sheets. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified.
 - 2. Bar bending details: The bars shall be referenced to the same identification marks shown on the placement drawings. Bars to have special coatings and/or to be of special steel or special yield strength are to be clearly identified.
- B Submit Test Reports, in accordance with Section 01300, of each of the following items.
 - 1. Certified copy of mill test on each steel proposed for use showing the physical properties of the steel.

2. Welder's certification: The certification shall be in accordance with AWS D1.4 in accordance with AWS D1.4 when welding of reinforcement is required.

1.04 REFERENCE STANDARDS

A American Society for Testing and Materials (ASTM)

1. ASTM A82 - Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A184 - Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
3. ASTM A185 - Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
4. ASTM A496 - Specification for Steel Wire, Deformed, for Concrete Reinforcement
5. ASTM A497 - Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
6. ASTM A615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

B American Concrete Institute (ACI)

1. ACI 117 - Standard Tolerance for Concrete Construction and Materials
2. ACI 301 - Specifications for Structural Concrete for Buildings
3. ACI 318 - Building Code Requirements for Reinforced Concrete
4. ACI 350R - Environmental Engineering Concrete Structures
5. SP-66 (ACI 315) ACI Detailing Manual

C Concrete Reinforcing Steel Institute (CRSI)

1. CRSI Handbook

D American Welding Society (AWS)

1. AWS D1.4 Structural Welding Code - Reinforcing Steel

E Section 400, Concrete and Reinforced Concrete, WAJ General Technical Specifications for Sewerage Works (1995).

F Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

G British Standards (BS)

1. BS 4449 Specification for Carbon Steel Bars for the Reinforcement for Concrete.
2. BS 4466 Specification for Bending Dimension and Scheduling and Reinforcement for Concrete
3. BS 4482 Cold Reduced Steel Wire for Reinforcement
4. BS 1052 Mild Steel Wire for General Engineering Purposes

1.05 DELIVERY, HANDLING AND STORAGE

- A Reinforcing steel shall be substantially free from mill scale, rust, dirt, grease, or other foreign matter.
- B Reinforcing steel shall be shipped and stored with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted Placing Drawings.
- C Reinforcing steel shall be stored off the ground, protected from moisture, and kept free from dirt, oil, or other injurious contaminants.

PART 2: PRODUCTS

2.01 MATERIALS

- A Materials shall be new and shall comply with the following material specifications.
1. Deformed High Strength Steel: BS 4449, 420 MPa deformed bars.
 2. Mild Strength Steel: BS 4449, 235 Mpa deformed 8 mm bars & strips.
 3. Concrete Reinforcing Bars required on the Drawings to be Field Bent or Welded: ASTM A706.
 4. Fabricated Deformed Steel Bar Mats: ASTM A184 and ASTM A615 Grade 60 deformed bars.
- B Reinforcing Steel Accessories
1. Plastic Protected Bar Supports: CRSI Bar Support Specifications, Class 1 - Maximum Protection.
 2. Stainless Steel Protected Bar Supports: CRSI Bar Support Specifications, Class 2 - Moderate Protection.
 3. Precast Concrete Block Bar Supports: CRSI Bar Support Specifications, Precast Blocks.

C Tie Wire

1. Tie Wires for Reinforcement shall be 16-gauge or heavier, black annealed wire.

2.02 FABRICATION

- A Fabrication of reinforcement shall be in compliance with the CRSI.
- B Bars shall be cold bent. Bars shall not be straightened or rebent.
- C Bars shall be bent around a revolving collar having a diameter of not less than that recommended by the CRSI.
- D Bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded, shall have the applicable end(s) saw-cut. Such ends shall terminate in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

PART 3: EXECUTION

3.01 INSTALLATION

- A Surface condition, bending, spacing, and tolerances of placement of reinforcement shall comply with the CRSI. The Contractor shall be solely responsible for providing an adequate number of bars and maintaining the spacing and clearances shown on the Drawings.
- B Except as otherwise indicated on the Drawings, the minimum concrete cover of reinforcement shall be as follows:
1. Concrete cast against and permanently exposed to earth and in foundations: 75 mm
 2. Concrete exposed to soil, water, sewage, sludge and/or weather: 50 mm
 3. Concrete not exposed to soil, water, sewage, sludge and/or weather:
 - a. Beams, slabs (top and bottom cover), walls, joists, shells and folded plate members - 30 mm
 - b. Columns (principal reinforcement, ties, spirals, and stirrups) - 40 mm
- C Reinforcement which will be exposed for a considerable length of time after being placed shall be coated with a heavy coat of neat cement slurry.
- D No reinforcing steel bars shall be welded either during fabrication or erection unless specifically shown on the Drawings or specified, or unless prior written approval has been obtained from the Engineer. All bars that have been welded, including tack welds, without such approval shall be immediately removed from the work. When welding of reinforcement is approved or called for, it shall comply with AWS D1.4.

- E Reinforcing steel interfering with the location of other reinforcing steel, conduits or embedded items, may be moved within the specified tolerances or one bar diameter, whichever is greater. Greater displacement of bars to avoid interference, shall only be made with the approval of the Engineer. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.
- F Securely support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.
- G Reinforcing steel bars shall not be field bent except where shown on the Drawings or specifically authorized in writing by the Engineer. If authorized, bars shall be cold-bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. If the reinforcing steel is damaged, replace, Cadweld or otherwise repair as directed by the Engineer. Do not bend reinforcement after it is embedded in concrete.

3.02 REINFORCEMENT AROUND OPENINGS

- A Unless specific additional reinforcement around openings is shown on the Drawings, provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by an opening. The bars shall have sufficient length to develop bond at each end beyond the opening or penetration.

3.03 SPLICING OF REINFORCEMENT

- A Bars shall be lapped at locations indicated on the drawings. Lap length shall be as shown on Drawing GS-1.
- B Splices designated as compression splices on the Drawings, unless otherwise noted, shall be as noted on Drawing GS-1. The lap splice length for column vertical bars shall be based on the bar size in the column as shown on Drawing GS-1.
- C Tension lap splices shall be provided at all laps in compliance with the applicable tables in the ACI 315, unless shown otherwise on drawings. Splices in adjacent bars shall be staggered.
- D Splice lengths in circumferential reinforcement in circular walls shall be as shown on drawings and shall be staggered. Adjacent bars shall not be spliced within the required lap length.
- E Splicing of reinforcing steel in concrete elements noted to be "tension members" on the Drawings shall be avoided whenever possible. However, if required for constructability, splices in the reinforcement subject to direct tension shall be welded to develop, in tension, at least 125 percent of the specified yield strength of the bar. Splices in adjacent bars shall be offset the distance of 60 bars diameters.
- F Install wire fabric in as long lengths as practicable. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI-318 but not less than 300 mm. The

spliced fabrics shall be tied together with wire ties spaced not more than 600 mm on center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams, or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.

3.04 ACCESSORIES

- A The Contractor shall be solely responsible for determining, providing and installing accessories such as chairs, chair bars, and the like in sufficient quantities and strength to adequately support the reinforcement and prevent its displacement during the erection of the reinforcement and the placement of concrete.
- B Use precast concrete blocks where the reinforcing steel is to be supported over soil.
- C Stainless steel bar supports or steel chairs with stainless steel tips shall be used where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use of plastic tipped metal chairs is permissible in all other locations unless otherwise noted on the Drawings or specified.
- D Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.
- E Install wire fabric in as long lengths as practicable. Splices in welded wire fabric shall be lapped in accordance with the requirements of ACI-318 but not less than 300 mm. The spliced fabrics shall be tied together with wire ties spaced not more than 600 mm on center and laced with wire of the same diameter as the welded wire fabric. Do not position laps midway between supporting beams or directly over beams of continuous structures. Offset splices in adjacent widths to prevent continuous splices.

3.05 INSPECTION

- A In no case shall any reinforcing steel be covered with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been observed by the Engineer and the Engineer's release to proceed with the concreting has been obtained. The Engineer shall be given ample prior notice of the readiness of placed reinforcement for observation. The forms shall be kept open until the Engineer has finished his observations of the reinforcing steel.

END OF SECTION

SECTION 03250

CONCRETE JOINTS AND ACCESSORIES

PART 1: GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required and install accessories for concrete joints and sealants as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A Concrete Formwork is included in Section 03100.
- B Concrete Reinforcement is included in Section 03200.
- C Cast-In-Place Concrete is included in Section 03300.
- D Concrete Finishing are included in Section 03350.
- E Grout is included in Section 03600.
- G Joint Sealants, Caulking, and Flashing are included in Section 07005.

1.03 SUBMITTALS

- A Shop drawings and product data, in accordance with Section 01300, shall include the following:
 - 1. Waterstops: Product data including catalogue cut sheets, technical data, storage requirements, splicing methods, and conformity to ASTM standards.
 - 2. Premolded joint fillers: Product data including catalogue cut sheets, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.
 - 2. Compressible joint filler: Product data including catalogue cut sheets, technical data, storage requirements, installation requirements, location of use, and conformity to ASTM standards.
- B Certifications
 - 1. Certification that all materials used within the joint system are compatible with each other.
 - 2. Certification that materials used in the construction of joints are suitable for use in contact with potable water and/or wastewater 30 days prior to installation.

1.04 REFERENCE STANDARDS

A American Society for Testing and Materials (ASTM)

1. A675 - Steel Bars, Carbon, Hot Wrought, Special Quality, Mechanical Properties.
2. ASTM C881 - Epoxy-Resin-Base Bonding Systems for Concrete.
3. ASTM C1059 - Latex Agents for Bonding Fresh to Hardened Concrete.
4. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.
5. ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

B U.S. Army Corps of Engineers (CRD).

CRD C572 - Specification for Polyvinyl chloride Waterstops.

C Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2: PRODUCTS

2.01 GENERAL

- A The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B All materials used together in a given joint (joint fillers, sealants, etc.) shall be compatible with one another. Coordinate selection of suppliers and products to ensure compatibility. Under no circumstances shall asphaltic bond breakers or joint fillers be used in joints receiving sealant.

2.02 MATERIALS

A Waterstops

1. Plastic Waterstops - Expansion joints; liquid retaining structure. 230 mm x 9.5 mm ribbed type waterstops with a center bulb made by extruding elastomeric plastic compound with virgin Polyvinyl chloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 123 kg/cm². The waterstop shall conform to CRD-C-572. The waterstop shall have an integral fastening system. Waterstops shall be Style CR-9380 by Paul Murphy Plastics Co., Roseville, MI; Style 696 by Greenstreak Plastic Products, St. Louis, MO; Style RLB 9-38 by Vinylex Corp., Knoxville, TN or equal.

2. Plastic Waterstop - Non-expansion joint; liquid retaining structure. 150 mm x 9.5 mm ribbed type waterstops made by extruding elastomeric plastic compound with virgin Polyvinyl chloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop shall be 123 kg/cm². The waterstop shall conform to CRD-C-572. The waterstop shall have an integral fastening system. Waterstops shall be style FR-6380 by Paul Murphy Plastics Co., Roseville, MI; Style 580 by Greenstreak Plastic Products, St. Louis, MO; Style R 6-38 by Vinylex Corp., Knoxville, TN or equal.

B Premolded Joint Filler

1. Premolded joint filler - structures. Closed cell modified vinyl foam, resiliency recovery of 95% if not compressed more than 50% of original thickness or premolded sponge rubber fully compressible with minimum recovery rate of 95% in accordance with ASTM D1752 type I. The thickness shall be 20 mm unless shown otherwise on the Drawings.
2. Premolded joint filler - sidewalk and roadway concrete pavements. Joints where fiber is specifically noted on the Drawings, shall be asphalt-impregnated fiber board. Joint filler shall conform to ASTM D1751. Thickness shall be 20 mm unless otherwise shown on the Drawings.

C Compressible Joint Filler

The joint filler shall be a non-extruded watertight strip material use to fill expansion joints between structures. The material shall be capable of being compressed at least 40 percent for 70 hours at 20°C subsequently recovering at least 20 percent of its original thickness in the first one-half hour after unloading. Compressible Joint filler shall be Evasote 380 E.S.P, by E-Poxy Industries, Inc., Ravena, NY or equal.

PART 3: EXECUTION

3.01 INSTALLATION

A Waterstops

1. Install waterstops for all joints where indicated on the Drawings. Waterstops shall be continuous around all corners and intersections so that a continuous seal is provided. Splices shall be made by welding in accordance with the manufacturer's recommendations, subject to acceptance of the Engineer. Only manufacturer's special approved tools shall be used for welding. The finished splices shall provide a cross-section that is dense and free of porosity.
2. To properly secure waterstops in wall joints before concrete is placed, use pre-drilled waterstops approximately 25 mm from each edge or between the outermost ribs at each edge and center the waterstop in the joint. Tie both edges of the waterstop to reinforcing steel with black annealed steel tie wire as specified for tying reinforcing steel and secure in place so that the waterstop will be perpendicular to the joint and remain in the required position during concrete placement.

3. The spacing of the waterstop ties shall match the spacing of the adjacent reinforcing, but need not be spaced closer than 300 mm on center.
4. Horizontal internal waterstops in slabs shall be clamped in position by the bulkhead (unless previously set in concrete) and the edge of the waterstop shall be lifted while placing concrete below the waterstop. Then the waterstop shall be manually forced against and into the placed concrete and covered with fresh concrete, to ensure adequate encasement of the waterstop in concrete.
5. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of splices.
6. Waterstops shall be installed so that half of the width will be embedded on each side of the joint. Care shall be exercised to ensure that the waterstop is completely embedded in void-free concrete.

B Construction Joints

1. Make construction joints only at locations shown on the Contract Drawings or as approved by the Engineer. Any additional or relocation of construction joints proposed by the Contractor, must be submitted to the Engineer for written approval.
2. Additional or relocated joints shall be located where they least impair strength of the member and shall not be made without the Engineer's approval.
3. All joints shall be perpendicular to main reinforcement. Reinforcing steel shall be continuous through the joint as indicated on the Drawings. When joints in beams are allowed, provide a shear key and inclined dowels as approved by the Engineer.
4. Provide sealant grooves for joint sealant where indicated on the Drawings.
5. At all construction joints and at concrete joints designated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points or side to side) of approximately 6 mm with suitable tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, the joints shall be saturated with water. After glistening water disappears, the joints shall be given a thorough coating of neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 3 mm thick, well scrubbed-in by means of stiff bristle brushes whenever possible. Horizontal wall joints with no access to the earlier concrete placement surface shall have the roughened surface thoroughly coated with a neat cement slurry of pouring consistency. New concrete shall be deposited before the neat cement dries.
6. In lieu of the above method for securing bond between new and set concrete, the following optional method may be used. Concrete must be allowed to set a minimum of 28 days. Use an epoxy bonding agent applied to roughened and cleaned surfaces of set concrete in strict accordance with manufacturer's recommendations with respect to preparation of surfaces and applications of bonding agent.

7. Provide waterstops in all wall and slab construction joints in liquid containment structures and at other locations shown on the Drawings.
8. Keyways shall not be used in construction joints unless specifically shown on the Drawings or approved by the Engineer.

B Control Joints

1. Provide sealant grooves, sealants at control joints in slabs on grade as detailed. Provide waterstops at all wall and slab control joints in water containment structures and at other locations shown on the Drawings.
2. Control joints may be sawed if specifically approved by the Engineer. If control joint grooves are sawed, properly time the saw cutting with the time of the concrete set. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw. Complete cutting before shrinkage stresses have developed sufficiently to induce cracking. No reinforcing shall be cut during saw cutting.
3. Extend every other bar of reinforcing steel through control joints or as indicated on the Drawings. Where specifically noted on the Drawings, the concrete surface at a control joint may require coating with a bond breaker prior to placing concrete on the other side of the joint. Avoid coating reinforcement or waterstops with bond breaker at these locations.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor and materials required and install cast-in-place concrete complete as shown on the Drawings and as specified herein.
- B Furnish all sampling and testing of materials and products by an independent testing laboratory acceptable to the Engineer but engaged by and at the expense of the Contractor.

1.02 RELATED WORK

- A Concrete Formwork is included in Section 03100.
- B Concrete Reinforcement is included in Section 03200.
- C Concrete Joint Accessories are included in Section 03250.
- D Concrete Finishing are included in Section 03350.
- E Moisture Protection is included in Division 7.

1.03 SUBMITTALS

- A Shop drawings and product data, in accordance with Section 01300 shall include the following:
 - 1. Sources of cement, aggregates, and water.
 - 2. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.
 - 3. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 4. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 5. High range water-reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations of use.

6. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.
7. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM standards. Identify proposed locations of use.

B Samples

Fine and coarse aggregates if requested for examination by the Engineer.

C Test Reports

1. Sieve analysis, mechanical properties and deleterious substance content for coarse and fine aggregate.
2. Chemical analysis and physical tests of each type of cement.
3. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, ratio of water to cementitious materials, type and manufacturer of cement.
 - a. Standard deviation data for each proposed concrete mix based on statistical records.
 - b. Curve showing the ratio of water to cementitious materials for concrete mixes based on laboratory tests. Give average Cube strength test results at 28 days for laboratory concrete mix designs. Provide results of 7 and 14 day tests if available.

D Certifications

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
2. Certify that admixtures are suitable for use in contact with potable water and wastewater both during and upon completion of concrete curing.
3. Certify curing compound is suitable for use in contact with potable water and wastewater (non-toxic and free of taste or odor).

1.04 REFERENCE STANDARDS

A American Society for Testing and Materials (ASTM)

1. ASTM C31 - Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33 - Concrete Aggregates.

3. ASTM C39 - Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42 - Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
6. ASTM C143 - Slump of Portland Cement Concrete
7. ASTM C150 - Standard Specification for Portland Cement
8. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete
9. ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method.
10. ASTM C231 - Air Content of Freshly Mixed Concrete by the Pressure Method.
11. ASTM C260 - Air-Entraining Admixtures for Concrete.
12. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
13. ASTM C494 Chemical Admixtures for Concrete.
14. ASTM C260 - Air-Entraining Admixtures for Concrete.
15. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
16. ASTM C494 Chemical Admixtures for Concrete.

B American Concrete Institute (ACI).

1. ACI 211.1 - Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
2. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.
3. ACI 304.2R - Placing Concrete by Pumping Methods.
4. ACI 305R - Hot Weather Concreting.
5. ACI 306R - Cold Weather Concreting.
6. ACI 318 - Building Code Requirements for Reinforced Concrete.
7. ACI 350R - Environmental Engineering Concrete Structures.
8. ACI 224R - Control of cracking in concrete structures.

B British Standards (BS)

1. BS 12 Specification for Portland cement
2. BS 6089. Guide to assessment of concrete strength in existing structures
3. BS 1881. Testing concrete

C Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A Only one source of cement and aggregates shall be used on any one structure. Concrete shall be uniform in color and appearance.
- B Well in advance of placing concrete, the Contractor shall discuss with the Engineer the sources of individual materials and batched concrete proposed for use. He shall discuss placement methods, waterstops and curing. He shall propose methods of hot and cold weather concreting as required.
- C If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. All changes so ordered shall be made at no additional expense to the Owner.
- D If, during the progress of the work, the materials from the sources originally accepted change in characteristics, the Contractor shall, at no additional expense to the Owner, make new acceptance tests of aggregates and establish new design mixes. Such testing and design shall be accomplished with the assistance of a certified independent testing laboratory acceptable to the Engineer.
- E Reinforced concrete shall comply with ACI 318, the recommendations of ACI 350 and other specifications, codes and standards.
- F Methods of testing shall comply in detail with the latest applicable ASTM Methods. Testing shall be done by an independent testing laboratory as specified in Section 01410.
- G Samples of constituents and of concrete as-placed will be subjected to laboratory tests. All materials incorporated in the Work shall conform to accepted samples.

1.06 DELIVERY, STORAGE AND HANDLING

- A Cement: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination and to minimize warehouse set.
- B Aggregate: Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive

horizontal layers not exceeding 1.0 m in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.

- C Sand: Arrange and use stockpiles to avoid contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen aggregates.
- D Admixtures: Store in closed containers to avoid contamination, evaporation or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.
- E Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.
- F Liquid curing compounds: Store in closed containers out of direct sunlight, except during periods of use. Containers shall be removed from direct sunlight as soon as practical after each application.

PART 2: PRODUCTS

2.01 GENERAL

- A The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.
- B Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.02 MATERIALS

- A Materials shall comply with these Specifications and any applicable State or local requirements.
- B Cement: Unless otherwise stated, the cement shall be ordinary Portland Cement originating from approved manufacturers, and shall comply with the requirements of and satisfy the tests contained in ASTM C150, BS 12 for ordinary Portland Cement and the American Association of State Highway and Transportation Officials (AASHTO) Specification M-85 "Portland Cement". Air entraining cements shall not be used. Cement brand shall be subject to approval by the Engineer and one brand shall be used throughout the Work.
- C Fine aggregate: Washed inert natural sand conforming to the requirements of ASTM C33.
- D Coarse aggregate: Well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Grading requirements shall be as listed in Table 2 of ASTM C33 for the size number corresponding to the appropriate maximum coarse aggregate size. Limits of Deleterious Substances and Physical Property Requirements shall be as listed in Table 3 of ASTM C33 for severe weathering regions. Size numbers for the concrete mixes shall be as shown in Table 1.

- E Water: Potable water free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.
- F Admixtures: Admixture shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures and shall be suitable for use in contact with potable water and wastewater. Approved admixtures shall be used strictly in accordance with the manufacturer's directions. The cost of comparative trial mixtures and tests for the approval of admixtures shall be at no additional expense to the Owner.
1. Air entraining admixture. The admixture shall comply with ASTM C260. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 2. Water reducing agent. The admixture shall comply with ASTM C494, Type A. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 3. High-Range Water Reducer (Plasticizer). Shall comply with ASTM C494 Type F and shall result in non-segregating plasticized concrete with little bleeding and physical properties of low water/cement ratio concrete. The treated concrete shall be capable of maintaining plastic state in excess of two hours. Proportioning and mixing shall be in accordance with manufacturer's recommendations.
 4. Admixtures causing retarded or accelerated setting of concrete shall not be used without written approval from the Engineer. When allowed, the admixtures shall be retarding or accelerating water reducing or high range water reducing admixtures.
- G Sheet Curing Materials. Waterproof paper, polyethylene film or white burlap-polyethylene sheeting all complying with ASTM C171.
- H Liquid Curing Compound. Liquid membrane-forming curing compound shall comply with the requirements of ASTM C309 Type 1-D (clear or translucent with fugitive dye) and shall contain no wax, paraffin, or oil. Curing compound shall be approved for use in contact with potable water (non-toxic and free of taste or odor).

2.03 MIXES

- A Development of mix designs and testing shall be by an independent testing laboratory acceptable to the Engineer and shall be engaged by the Contractor and at no additional expense to the Owner.
- B Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placeability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and

around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.

- C The design mix shall be based on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, be developed by laboratory tests. Water content of the concrete shall be based on a curve showing the relation between water cementitious ratio and 7 and 28 day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the required design strengths. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1.
- D Compression Tests: Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318.
- E Shrinkage Tests: Perform shrinkage tests on the design mix for concrete. The tests shall conform to ASTM C157 as modified by ASTM C596. Concrete and not mortar specimens shall be used. The average shrinkage at 25 days of air storage shall not exceed 0.036 percent.
- F Entrained air, as measured by ASTM C231, shall be as shown in Table 1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal.

TABLE 1

INSITU CONCRETE MIXES, CASTING AND CURING SCHEDULE

Concrete Grade	Concrete Element	Minimum cement contents (Kg/cu.m)	Cube Strength (N/mm ²)		Aggregate	Maximum free-water / cement ratio	Cement Type	Slump
			at 7 days	at 28 days				
Grade 15	Mass concrete and blinding	250	10	15	20mm	0.6	Type I (ASTM C150)	75-125
Grade 30	Columns, slabs, beams, slabs on grade, walls, foundations, tie beams and all other concrete elements of building.	350	20	30	20mm	0.5	Type I (ASTM C150)	100-150

NOTES:

1. Minimum compressive strength at 28 days in Newton per square millimeter.
2. ASTM designation
3. Minimum cement content in kgs per cubic meter
4. AE is percent air entrainment
5. WR is water reducing admixture
6. HRWR is high range water reducer
7. RET is set retarder to be used in hot weather and only if approved by the Engineer(*)

- G Slump of the concrete measured in accordance with the requirements of ASTM C143, shall be as shown in Table 1. If plasticizer is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 175 to 250 mm.
- H Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

PART 3: EXECUTION

3.01 MEASURING MATERIALS

- A Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water and admixtures as specified and shall be produced by a plant acceptable to the Engineer. All constituents, including admixtures, shall be batched at the mixing plant.
- B Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Scales shall have been certified by the local Sealer of Weights and Measures within one year of use.
- C Measure the amount of free water in fine aggregates within 0.3 of a percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of liters of water as-batched on printed batching tickets.
- D Admixtures shall be dispensed either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 - 1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 - 2. Inject multiple admixtures separately during the batching sequence.

3.02 MIXING AND TRANSPORTING

- A Concrete shall be batch-mixed concrete produced by equipment acceptable to the Engineer. No hand-mixing will be permitted.
- B All central plant and rolling stock equipment and methods shall comply with ACI 318 and ASTM C94.
- C Retempering of concrete or mortar which has partially hardened (that is, mixing with or without additional cement, aggregate, or water) will not be permitted.
- D Temperature and Mixing Time Control

1. In cold weather maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 2.
2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 32 degrees C.
3. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 32 degrees C. If necessary, substitute well-crushed ice for all or part of the mixing water.
4. The maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms shall not exceed the following:

TABLE 2

AIR OR CONCRETE (WHICHEVER IS HIGHER)	TEMPERATURE	MAXIMUM TIME
	-----	-----
	27 Degree C to 32 Degree C	45 minutes
	21 Degree C to 26 Degree C	60 minutes
	5 Degree C to 20 Degree C	90 minutes

If an approved high range water reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

3.03 INSPECTION AND COORDINATION

- A The batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the Engineer at all times. The Contractor shall advise the Engineer of his readiness to proceed at least 24 hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness and tightness of formwork. No placement shall be made without the inspection and acceptance of the Engineer.

3.04 CONCRETE APPEARANCE

- A Concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste shall be remixed. If this does not correct the condition, the concrete shall be rejected. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, changes in the concrete mix shall be obtained only by adjusting one or more of the following:
1. The gradation of aggregate.
 2. The proportion of fine and coarse aggregate.
 3. The percentage of entrained air, within the allowable limits.
- B Concrete for the Work shall provide a homogeneous structure which, when hardened, will have the required strength, durability and appearance. Mixtures and workmanship shall be

such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete when viewed in good lighting from 3 m away shall be pleasing in appearance, and at 6 m shall show no visible defects.

3.05 PLACING AND COMPACTING

A Placing

1. Verify that all formwork completely encloses concrete to be poured and is securely braced prior to concrete placement. Remove ice, excess water, dirt and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent workman at the location of the pour who can assure that reinforcement and embedded items remain in designated locations while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Seal extremely porous subgrades in an approved manner.
2. Deposit concrete as near its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate which ensures that previously placed concrete is being integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes suitable for pumping and submit for approval.
4. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.
5. Do not place concrete for supported elements until concrete previously placed in the supporting element (columns, slabs and/or walls) has reached adequate strength.
6. Where surface mortar is to form the base of a finish, especially those designated to be painted, work coarse aggregate back from forms with a suitable tool to bring the full surface of the mortar against the form. Prevent the formation of excessive surface voids.
7. Slabs
 - a. After suitable bulkheads, screeds and jointing materials have been positioned, the concrete shall be placed continuously between construction joints beginning at a bulkhead, edge form, or corner. Each batch shall be placed into the edge of the previously placed concrete to avoid stone pockets and segregation.
 - b. Avoid delays in casting. If there is a delay in casting, the concrete placed after the delay shall be thoroughly spaded and consolidated at the edge of that previously placed to avoid cold joints. Concrete shall then be brought to correct level and

struck off with a straightedge. Bullfloats or darbies shall be used to smooth the surface, leaving it free of humps or hollows.

- c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow one hour to pass between placement of the wall and the overlying slab to permit concrete consolidation of the wall concrete. Keep the top surface of the wall moist so as to prevent cold joints.
8. Formed Concrete: Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not drop concrete more than 1.2 m. Place concrete for walls in 300 mm to 600 mm lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 2.1 m and the maximum free fall of concrete shall not exceed 4.6 m.

B Compacting

1. Consolidate concrete by vibration, puddling, spading, rodding or forking so that concrete is thoroughly worked around reinforcement, embedded items and openings and into corners of forms. Puddling, spading, etc., shall be continuously performed along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting or planes of weakness.
2. All concrete shall be placed and compacted with mechanical vibrators. The number, type and size of the units shall be approved by the Engineer in advance of placing operations. No concrete shall be ordered until sufficient approved vibrators (including standby units in working order) are on the job.
3. A minimum frequency of 7000 revolutions per minute is required for mechanical vibrators. Do not use vibrators to transport concrete within forms. Insert vibrators and withdraw at points from 450 - 750 mm apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.
4. Concrete Slabs: Concrete for slabs less than 200 mm thick shall be consolidated with vibrating screeds; slabs 200 mm to 300 mm thick shall be compacted with internal vibrators and (optionally) with vibrating screeds. Vibrators shall always be placed into concrete vertically and shall not be laid horizontally or laid over.
5. Walls and Columns: Internal vibrators (rather than form vibrators) shall be used wherever possible. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. The vibrators shall be inserted vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete, but not to move or transport concrete in the forms. Vibration shall continue until:

- a. Frequency returns to normal.
- b. Surface appears liquefied, flattened and glistening.
- c. Trapped air ceases to rise.
- d. Coarse aggregate has blended into surface, but has not disappeared.

3.06 CURING AND PROTECTION

A Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B Curing Methods

1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of seven days after placement. Curing methods to be used are as follows:
 - a. Water Curing: Keep entire concrete surface wet by puddling, continuous sprinkling or covered with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.
 - b. Sheet Material Curing: Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
 - c. Liquid Membrane Curing: Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed. Curing compound shall be applied as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Application shall be in compliance with the manufacturer's recommendations.
2. Specified applications of curing methods.
 - a. Slabs for Water Containment Structures: Water curing only.
 - b. Slabs on Grade and Footings (not used to retain water): Water curing, sheet material curing or liquid membrane curing.
 - c. Structural Slabs (other than water containment): Water curing or liquid membrane curing.
 - d. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water curing.
 - e. Formed Surfaces: None if nonabsorbent forms are left in place seven days. Water cure if absorbent forms are used. Sheet cured or liquid membrane cured if forms are removed prior to seven days. Exposed horizontal surfaces of formed

walls or columns shall be water cured for seven days or until next placement of concrete is made.

f. Concrete Joints: Water cured or sheet material cured.

C Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

D Cold Weather Concreting:

1. For this Specification, “cold weather” is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 5 degrees C. The average daily temperature shall be calculated as the average of the highest and the lowest temperature during the period from midnight to midnight.
2. Concrete placed during cold weather shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 306R and the additional requirements of this Section.
3. The Contractor shall discuss their cold weather work plan with the Engineer. The discussion shall encompass the methods and procedures proposed for use during cold weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete. The procedures to be implemented upon abrupt changes in weather conditions or equipment failures shall also be discussed. Cold weather concreting shall not begin until the work plan is acceptable to the Engineer.
4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 10 degrees C. Prevent overheating and non-uniform heating of the concrete.

TABLE 3

Concrete Temperatures
Minimum Dimension of Section

	<u>≤ 300 mm</u>	<u>300 to 900 mm</u>
Min. conc temp:	13 Degree C	10 Degree C

5. During periods of cold weather, concrete shall be protected to provide continuous warm, moist curing (with supplementary heat when required) for a total of at least 100 degree-days of curing.
 - a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (eg: 5 days at an average 20 degrees C = 100 degree-days).

- b. To calculate the weighted average daily air temperature, sum hourly measurement of the air temperature in the shade at the surface of the concrete taking any measurement less than 10 degrees C as 0 degrees C. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.
6. Salt, manure or other chemicals shall not be used for protection.
7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, the concrete shall not be exposed to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated.
8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

E Hot Weather Concreting

1. For this Specification, "hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R-77, approaching or exceeding 0.98 kgF/m²/hr.
2. Concrete placed during hot weather, shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305R and the additional requirements of this Specification.
 - a. Temperature of concrete being placed shall not exceed 32 degrees C and every effort shall be made to maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set or cold joints.
 - b. All necessary precautions shall be taken to promptly deliver, to promptly place the concrete upon its arrival at the job and to provide vibration immediately after placement.
 - c. The Engineer may direct the Contractor to immediately cover plastic concrete with sheet material.
3. The Contractor shall discuss with the Engineer a work plan describing the methods and procedures he proposes to use for concrete placement and curing during hot weather periods. Hot weather concreting shall not begin until the work plan is acceptable to the Engineer.

3.07 REMOVAL OF FORMS

- A Except as otherwise specifically authorized by the Engineer, forms shall not be removed before the concrete has attained a strength of at least 30 percent of the 28 day compressive strength

prescribed by the design, nor before reaching the following number of day-degrees of curing (whichever is the longer):

TABLE 4

Forms For -----	Degree Days -----
Beams and slabs	500
Walls and vertical surfaces	100

(Degree-days are defined as the total number of 24 hr periods multiplied by the weighted average daily air temperature at the surface of the concrete, (e.g., 5 days at an average of 20 degrees C = 100).

- B Shores shall not be removed until the concrete has attained at least 70% of the specified strength and also sufficient strength to safely support its own weight and the construction live loads upon it.

3.08 FIELD TESTS

- A Sets of field control cube specimens will be taken by an independent testing laboratory, as specified in Section 01410, during the progress of the Work. All field control cube specimens taken shall be in compliance with British Standard 1881. The number of sets of concrete test cubes taken for each class of concrete placed each day shall not be less than one per day, nor less than one for each 115 cu.m. of concrete nor less than one for each 500 sq.m of surface area for slabs or walls.
 - 1. A "set" of test cubes consists of six cubes: three to be broken at seven days and two to be broken and their strengths averaged at 28 days. The remaining cube may be used for a special break at 3 days or to verify strength after 28 days if 28 day breaks are low.
 - 2. When the average 28 day compressive strength of the cubes in any set falls below the required compressive strength or below proportional minimum seven-day strengths (where proper relation between seven and 28 day strengths have been established by tests), proportions, water content, or temperature conditions shall be changed to achieve required strengths.
- B The Contractor shall cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through his operations, and furnishing material and labor required for the purpose of taking concrete cube samples. All shipping of specimens will be paid for by the Contractor. Curing boxes shall be acceptable to the Engineer.
- C Slump tests will be made in the field immediately prior to placing the concrete. Such tests shall be made in accordance with ASTM C143. If the slump is greater than that specified, the concrete shall be rejected.

- D Air Content: Test for air content shall be made on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If lightweight aggregates or aggregates with high absorptions are used, the latter test method shall be used.

3.09 FIELD CONTROL

- A The contractor shall advise the Engineer of his readiness to proceed prior to each concrete placement. The Engineer will inspect the preparations for including the preparation of previously placed concrete, the reinforcing and the alignment and tightness of formwork. No placement shall be made without the prior approval of the Engineer.
- B The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work.
- C The Contractor shall cooperate in obtaining cores by allowing free access to the Work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. The Contractor shall repair all core holes. The work of cutting and testing the cores will be at the expense of the Owner.

3.10 FAILURE TO MEET REQUIREMENTS

- A Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer shall have the right to require changes in proportions outlined to apply on the remainder of the Work. Furthermore, the Engineer shall have the right to require additional curing on those portions of the structure represented by the test specimens which failed. The cost of such additional curing shall be at no additional expense to the Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer shall have the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at no additional expense to the Owner. In such cases of failure to meet strength requirements the Contractor and Engineer shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94 and/or BS 6089. The "purchaser" referred to in C94 is the Contractor in this Specification.
- B When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In case of failure of the cores, the Engineer, in addition to other recourses, may require, at no additional expense to the Owner, load tests on any one of the slabs, beams, piles, caps, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days.

- C CONCRETE REJECTED for non-compliance of mix to be cut out and replaced with complying concrete at contractor's expense.

3.11 PATCHING

- A As soon as the forms have been stripped and the concrete surfaces exposed, fins and other projections shall be removed, recesses left by the removal of form ties shall be filled, and surface defects which do not impair structural strength shall be repaired. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to approval of the Engineer.
- B Immediately after removal of forms remove plugs and break off metal ties as required by Section 03100 FORMWORK. Holes are then to be promptly filled upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spiderweb. Trowel smooth with heavy pressure. Avoid burnishing.
- C When patching exposed surfaces the same source of cement and sand as used in the parent concrete shall be employed. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with a fine Carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

3.12 REPAIRS

- A It is the intent of these Specification to require quality work including adequate forming, proper mixture and placement of concrete and curing so completed concrete surfaces will require no patching.
- B Defective concrete and honeycombed areas as determined by the Engineer.

3.13 MISCELLANEOUS WORK

- A All bolts, anchors, miscellaneous metals or other sleeves and steel work required to be set in the concrete forms for attachment of masonry, structural, and mechanical equipment shall be set or installed under this Section. The Contractor shall be fully responsible for the setting of such materials in the forms and shall correct all such not installed in a proper location or manner at his own expense.
- B Pipes or conduits for embedment, other than those merely passing through shall not be larger in outside diameter than one-third the thickness of the slab, wall, or beam in which they are embedded, unless indicated on the Drawings, nor shall they be spaced closer than three (3) diameters on center, nor so located as to unduly impair the strength of the construction. The Engineer shall approve the location of all conduits and fixtures.

- C Concrete foundations, supports and bases for all equipment and machinery shall be built to the equipment manufacturer's requirements, as approved by the Engineer, with anchor bolts installed.
- D All motor control centers and power control centers shall be installed on 100 mm minimum depth concrete bases above the finished floor levels.

END OF SECTION

SECTION 03350

CONCRETE FINISHING

PART 1: GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required to finish cast-in-place concrete surfaces as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A Concrete Formwork is included in Section 03100.
- B Cast-In-Place Concrete is included in Section 03300.
- C Grout is included in Section 03600.

1.03 SUBMITTALS

- A Submit shop drawings and product data, in accordance with Section 01300 showing materials of construction and details of installation for:
 - 1. Floor hardener. The submittal shall also include documentation on the successful application of at least 50,000 square meters of the proposed hardener at an application rate equal to or greater than recommended for this project.
 - 2. Concrete sealer. Confirmation that the sealer is compatible with additionally applied coatings shall also be submitted.
 - 3. Finishing to concrete floor slabs with cement screed.

1.04 REFERENCE STANDARDS

- A American Society for Testing and Materials (ASTM)
 - 1. ASTM C33 - Concrete Aggregates.
- B Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A Finishes
 - 1. For concrete which will receive additional applied finishes or materials, the surface finish specified is required for the proper application of the specified manufacturer's products. Where alternate products are approved for use, determine if changes in finishes are required and provide the proper finishes to receive these products.

2. Changes in finishes made to accommodate products different from those specified shall be performed at no additional cost to the Owner. Submit the proposed new finishes and their construction methods to the Engineer for approval.

B Services of Manufacturer's Representative: The Contractor shall make available at no extra cost to the Owner, upon 72 hours notification, the services of a qualified field representative of the manufacturer of curing compound, sealer or hardener to instruct the user on the proper application of the product under prevailing job conditions.

PART 2: PRODUCTS

2.01 MATERIALS

A Floor hardener shall be non-metallic and consist of specially processed, natural aggregate, cementitious binder, plasticizer and water reducing admixtures, formulated and processed under the stringent quality control of the manufacturer in their own facilities. The floor hardener shall be applied according to the manufacturer's recommendations for heavy traffic areas. Examples of such material are Master Builders, Cleveland, OH - Mastercron, or approved equal.

B Concrete sealer shall be "Kure-N-Seal", by Sonneborn, Minneapolis, MN; or approved equal.

C The screed shall consist of one part ordinary Portland cement to three parts sand by volume.

PART 3: EXECUTION

3.01 FORMED SURFACES

A Forms shall not be removed before the requirements of Section 03300, have been satisfied.

B Exercise care to prevent damaging edges or obliterating the lines of chamfers, rustications or corners when removing the forms or performing any other work adjacent thereto.

C Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

D Rough-Form Finish

1. Immediately after stripping forms and before concrete has changed color, carefully remove all fins and projections.

2. Promptly fill holes left by tie cones and defects as specified in Section 03300.

E Fair Faced Finish

1. Provide faire face finished surfaces that are to be exposed-to-view or that are to be covered with a thin coating material applied directly to the concrete such as painting or other similar system.

2. The faire face smooth finish shall be obtained with special form facing material, to provide flat surfaces as shown on the drawings.
3. Surfaces of this type of concrete shall conform to the same requirements as those for Standard Smooth Concrete. Except Faire Face concrete shall:
 - One. Have no surface irregularity whatsoever.
 - Two. Be absolutely homogeneous and harmonious
 - Three. Shall not have more than 10 No. blowholes of 3mm- 12mm in diameter per square meter.
4. No repair is permitted whatsoever to this type of concrete.
5. Standard Smooth Finish
 1. Provide standard smooth finish for all concrete formed surfaces that are to be exposed-to-view or that are to be covered with a coating material applied directly to the concrete or a covering material bonded to the concrete such as waterproofing, dampproofing, painting or other similar system.
 2. Standard smooth finish shall be the as-cast concrete surface as obtained with the form facing material.
 3. The surface of this type of concrete shall conform with the following:
 - One. Shall have no surface irregularity exceeding 3mm in any direction at any one level notwithstanding its size.
 - Two. Shall be harmonious in colour, shade and feel to the hand.
 - Three. Shall not have any defects or protrusions, honeycombs, sapling, chipping, scoring, scaling, imposed from patterns or blowholes exceeding 12mm in size, with a maximum number of 32 blowholes of 3mm-12mm in diameter per square meter.
 4. A minimum amount of repair is permissible and only to limited areas, subject to the approval of the Engineer.

3.02 FLOORS AND SLABS

A Floated Finish:

1. Machine Floating

- a. Screed floors and slabs with straightedges to the established grades shown on the Drawings. Immediately after final screening, a dry cement/sand shake in the proportion of two sacks of Portland cement to 160 kg of coarse natural concrete sand shall be sprinkled evenly over the surface at the rate of approximately 2.5 kg per square meter of floor. Do not sprinkle neat, dry cement on the surface.
- b. The application of the cement/sand shake may be eliminated at the discretion of the Engineer if the base slab concrete exhibits adequate fattiness and homogeneity, and the need is not indicated. When the concrete has hardened sufficiently to support the weight of a power float without its digging into or disrupting the level surface, thoroughly float the shake into the surface with a heavy revolving disc type power compacting machine capable of providing a 90 kg compaction force distributed over a 600 mm diameter disc.
- c. Start floating along walls and around columns and then move systematically across the surface leaving a matte finish.
- d. The compacting machine shall be the "Kelly Power Float with Compaction Control" as manufactured by Kelley Industries of SSP Construction Equipment, Inc., Pomona, CA, or approved equal. Troweling machines equipped with float (shoe) blades that are slipped over the trowel blades may be used for floating. Floating with a troweling machine equipped with normal trowel blades shall not be permitted. The use of any floating or troweling machine which has a water attachment for wetting the concrete surface during finishing shall not be permitted.

2. Hand Floating

In lieu of power floating, small areas may be compacted by hand floating. The dry cement/sand shake previously specified shall be used unless specifically eliminated by the Engineer. Screed the floors and slabs with straightedges to the established grades shown on the Drawings. While the concrete is still green, but sufficiently hardened to support a finisher and kneeboards with no more than 6 mm indentation, wood float to a true, even plane with no coarse aggregate visible. Use sufficient pressure on the wood floats to bring moisture to the surface.

3. Finishing Tolerances

Level floors and slabs to a tolerance of plus or minus 3 mm when checked with a 3 meter straightedge placed anywhere on the slab in any direction. Where drains occur, pitch floors to drains such that there are no low spots left undrained. Failure to meet either of the above requirements shall be cause for removal, grinding, or other correction as directed by the Engineer.

B Broom Finish

Screed slabs with straight edges to the established grades indicated on the Drawings. When the concrete has stiffened sufficiently to maintain small surface indentations, draw a stiff bristle broom lightly across the surface in the direction of drainage, or, in the case of walks and stairs, perpendicular to the direction of traffic to provide a non-slip surface.

C Steel Trowel Finish

Hand steel trowel to a perfectly smooth hard even finish free from high or low spots or other defects.

D Floor Hardener

1. Floor slabs indicated on the room finish schedule to receive a hardener shall have the hardener applied as follows:
 - a. Soak hardener in clean water for 10 minutes prior to application and allow to drain. Upon completion of concrete placement, screening and floating as specified herein, make one steel trowel pass before application of the dry shake. As soon as surface water disappears, sprinkle hardener uniformly over the surface in one application at a rate of 1.1 kg per square meter and embed it in concrete with the float.
 - b. Compact the floor or slab to a non-slip surface by troweling, continuing until sufficient mortar is brought to the surface to fill all voids. Test the surfaces with a straight edge to detect high and low spots which shall be eliminated. After curing, if finish is too smooth, acid etch with diluted muratic acid and flush with clean water.
 - c. Continue compaction only until thorough densification is attained and a small amount of mortar is brought to the surface. Avoid excessive floating.

E Concrete Sealer

1. Prepare and seal surfaces indicated on the room finish schedule to receive a sealer as follows:
 - a. Finish concrete as specified herein.
 - b. Newly Placed Concrete. Surface must be sound and properly finished. Surface is application-ready when it is damp but not wet and can no longer be marred by walking workmen.
 - c. Newly-Cured Bare Concrete: Level any spots gouged out by trades. Remove all dirt, dust, droppage, oil, grease, asphalt and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry so that surface is no more than damp, and not wet.

- d. Aged Concrete: Restore surface soundness by patching, grouting, filling cracks and holes, etc. Surface must also be free of any dust, dirt, and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required, following the procedure indicated under cured concrete.
- e. Methods: Apply sealer so as to form a continuous, uniform film by spray, soft-bristle pushbroom, long-nap roller or lambswool applicator. Ordinary garden-type sprayers, using neoprene hose, are recommended for best results.
- f. Applications: For curing only, apply first coat evenly and uniformly as soon as possible after final finishing at the average rate of 30 square meters per gallon. Apply second coat when all trades are completed and structure is ready for occupancy at the average rate of 50 square meters per gallon.
- g. To meet guarantee and to seal and dustproof, two coats are required. For sealing new concrete, both coats shall be applied full-strength. On aged concrete, when renovating, dustproofing and sealing, the first coat should be thinned 10 to 15 percent with reducer per manufacturer's directions.

3.03 APPROVAL OF FINISHES

- A All concrete surfaces, when finished, will be inspected by the Engineer.
- B Surfaces which, in the opinion of the Engineer, are unsatisfactory shall be refinished or reworked.
- C After finishing horizontal surfaces, regardless of the finishing procedure specified, the concrete shall be cured in compliance with Section 03300 unless otherwise directed by the Engineer.

3.04 SCHEDULE OF FINISHES

- A Concrete shall be finished as specified either to remain as natural concrete to receive an additional applied finish or material under another section.
- B Concrete for the following conditions shall be finished as noted on the Drawings and as further specified herein:
 - 1. Concrete to Receive Dampproofing: Standard smooth finish.
 - 2. Concrete Not Exposed to View and Not Scheduled to Receive an Additional Applied Finish or Material: Rough-form finish.
 - 3. Vertical Concrete in Water Containment Areas: Fair faced finish.
 - 4. Interior or Exterior Horizontal Concrete not Requiring Floor Hardener or Sealer: Floated finish.

5. Concrete for Exterior Walks, Exterior Stairs: Broomed finish perpendicular to direction of traffic.
6. Concrete Slabs On Which Process Liquids Flow or In Contact with Sludge: Steel trowel finish.
7. Concrete to Receive Hardener: See previous text.
8. Concrete to Receive Floor Sealer: See previous text.
9. Exposed interior concrete, including underside slabs, beams and stairs of openings, beams and stairs – Rough form finish.
10. Concrete to receive roof membrane - Consolidate, screed, and wood float to required grades.
11. Tops of curbs and pads - steel trowel finish.
12. Concrete to receive bounded ceramic tile - steel trowel followed by light brooming.
13. Concrete to receive finish plaster: Rough form finish.

END OF SECTION

SECTION 03400

LIGHTWEIGHT INSULATING CONCRETE

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment, and incidentals required to provide and install lightweight insulating concrete as shown on the Drawings and as specified herein. The lightweight insulating concrete work shall be on roof decks of all structures as indicated on the Drawings.

1.02 QUALITY ASSURANCE

- A Material Evaluation Tests: Perform material evaluation tests, for quality control and the design of concrete mixes.

Materials and installed work may require testing and retesting at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times. Test, including the retesting of rejected materials and installed work, are to be carried out at the Contractor's expense.

- B Codes and Standards: Comply with the requirements of the following Codes and Standards:

ASTM - American Society for Testing and Materials

- C 138 Test for Unit Weight, Yield and Air Content of Concrete
- C 150 Specification for Portland Cement
- C 172 Sampling Fresh Concrete
- C 260 Specification for Air-Entraining Admixtures for Concrete.
- C 332 Specification for Lightweight Aggregates for Insulating Concrete.
- C 495 Test for Compressive Strength of Lightweight Insulating Concrete.

1.03 SUBMITTALS

- A General: In addition to submittals listed below and prior to purchase, provide catalog cuts and manufacturer's data for all items to be purchased, for review by the Engineer.
 - 1. Samples of Materials as specified, including names, sources and descriptions as required.
 - 2. Laboratory test reports for materials, mix design tests and quality control tests.

- B Reports: Submit written report to the Engineer for review for each material sampled and tested, prior to the start of work. Provide the project identification name and number, date of report, name of Contractor, source of materials, manufacturers and brand names, values specified in the referenced specification for each material and test results. Indicate whether or not material is acceptable for intended use.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A Deliver materials in manufacturer's original undamaged packages and store off the ground and in covered sheds to protect them from damage and deterioration. Do not use materials which show indications of moisture damage, caking or other signs of deterioration.

1.05 JOB CONDITIONS

- A Do not place lightweight insulating concrete during sandstorms or rain or when ambient temperature is above 32 degree C or below freezing. Do not place lightweight insulating concrete except in compliance with requirements of cold weather and hot weather concreting and as specified by the manufacturer and ordered by the Engineer.

PART 2: PRODUCTS

2.01 MATERIALS

- A Proprietary Lightweight Insulation Material: Expanded 'Perlite' as manufactured by Arab Insulating Materials Co., Amman, or approved equal.
- B Portland Cement: ASTM C 150. Type 1.
- C Aggregate: ASTM C 332, GROUP 1.
- D Water: Clean, fresh, potable
- E Expansion Joint Filler: Refer to Section 07005 Joint Sealants Caulking, and Flashing.

2.02 DESIGN MIX

- A Design lightweight insulating concrete mix to produce the following physical properties.
 1. Oven Dry Density 430 kg/m³ plus or minus 20kg/m³, when tested in accordance with ASTM C 495.
 2. Compressive Strength Minimum 0.96mpa. when tested in accordance with ASTM C 495.
 3. Thermal Conductivity: 0.075W/m² degree C.
- B Use only the minimum amount of water necessary to produce a workable mix.
- C Do not exceed air content recommended by manufacturer.

PART 3: EXECUTION

3.01 INSPECTION

- A Contractor shall examine the areas and conditions under which lightweight insulating concrete is to be placed and correct all unsatisfactory conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.02 INSTALLATION

- A Installation of light weight concrete shall be carried out by the manufacturer or his approved representative.
- B Lightweight insulating concrete shall be placed using equipment and procedures to avoid segregation of the mix and in strict accordance with the manufacturer's instructions. Deposit and screed in a continuous operation until an entire panel or section of the roof area is completed. Do not vibrate or work the mix except for screeding or floating or as directed by the manufacturer. Place lightweight insulating concrete to the depths and slopes as indicated on the drawings, to produce the required degree of insulation.
- C Begin curing operations immediately after placement in accordance with weather and job conditions, strictly adhering to the manufacturer's instructions.
- D Following curing operation, lightweight insulating concrete shall receive a cement and sand (1:4) screed having a 30mm minimum thickness. Screed shall be well finished and troweled smooth.

3.03 FIELD QUALITY CONTROL

- A The Contractor is to take samples and conduct tests to evaluate lightweight insulating concrete.

Taking samples in accordance with ASTM C 172, except as modified by ASTM C 495.

1. Determine wet density in accordance with ASTM C 138.
2. Determine compressive strength and oven dry density in accordance with ASTM C495. Make at least 5 molds during each placement.

- B Report test results to the Engineer immediately after completion of each test.

3.04 DEFECTIVE WORK

- A Refinish or remove and replace lightweight insulating concrete with objectionable thermal properties or with cracks and other defects which affect the performance of the lightweight insulating concrete or when physical properties do not meet specified requirements, as directed by the Engineer and in strict compliance with the manufacturer's instructions.

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

- A Formwork is included in Section 03100.
- B Concrete Reinforcement is included in Section 03200.
- C Concrete Joints and Joint Accessories are included in Section 03250.
- D Cast-in-Place Concrete is included in Section 03300.

1.03 SUBMITTALS

- A Submit to the Engineer, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:
 - 1. Commercially manufactured nonshrink cementitious grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.
 - 2. Commercially manufactured nonshrink epoxy grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.
 - 3. Cement grout. The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures and the proposed mix of the grout.
- B Samples
 - 1. Samples of commercially manufactured grout products when requested by the Engineer.
 - 2. Aggregates for use in concrete grout when requested by the Engineer.
- C Laboratory Test Reports

Submit laboratory test data as required under Section 03300 for concrete to be used as concrete grout.

D Certifications

Certify that commercially manufactured grout products and concrete grout admixtures are suitable for use in contact with potable water after 30 days curing.

E Qualifications

Grout manufacturers shall submit documentation that they have at least 10 years experience in the production and use of the proposed grouts which they will supply

1.04 REFERENCE STANDARDS

A American Society for Testing and Materials(ASTM).

1. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacing.
2. ASTM C579 - Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes.
3. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
4. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
5. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

B Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A Qualifications

Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.

B Field Testing

The independent testing laboratory shall be as specified in Section 01410.

C Pre-installation Conference

Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days prior to its scheduled date.

1.06 DELIVERY, STORAGE AND HANDLING

- A Deliver materials to the job site in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.
- B Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.
- C Material which becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the Owner.
- D Nonshrink cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.
- E Nonshrink epoxy grouts shall be delivered as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

PART 2: PRODUCTS

2.01 GENERAL

- A The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.
- B Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.
- C Nonshrink Grout is defined as a commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

2.02 MATERIALS

- A Nonshrink Cementitious Grout: Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107 Grades B or C and CRD-C 621. Grouts shall be Portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.
 - 1. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; Set Grout by Master Builders, Inc.;

Gilco Construction Grout by Gifford Hill & Co.; Euco NS by The Euclid Chemical Co.; NBEC Grout by U. S. Grout Corp., or approved equal.

2. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by Master Builders, Inc.; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Supreme Grout by Gifford Hill & Co.; Five Star Grout by U. S. Grout Corp., or approved equal.
- B Nonshrink Epoxy Grout: Nonshrink epoxy-based grout shall be a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 985 kg/cm² in 7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30 x 10⁻⁶ when tested in conformity with ASTM C531. The grout shall be Ceilcote 648 CP by Master Builders, Inc.; Five Star Epoxy Grout by U.S. Grout Corp.; Sikadur 42 Grout-Pak by Sika Corp.; High Strength Epoxy Grout by the Euclid Chemical Co., or approved equal.
- C Cement Grout: Cement grouts shall be a mixture of one part Portland cement conforming to ASTM C150 Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.
- D Water: Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

- A Grout shall be placed over cured concrete which has attained its full design strength unless otherwise approved by the Engineer.
- B Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may affect the bond or performance of the grout.
- C Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.
- D Remove all loose rust, oil or other deleterious substances from metal embedments or bottom of baseplates prior to the installation of the grout.
- E Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the Engineer. Upon completion of the 24 hour period, visible water

shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the Engineer for each specific location of grout installation.

- F Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- G Construct grout forms or other leakproof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- H Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.
- I Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Engineer.

3.02 INSTALLATION - GENERAL

- A Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.
- B Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.
- C Maintain temperatures of the foundation plate, supporting concrete, and grout between 15 degrees C and 32 degrees C during grouting and for at least 24 hours thereafter until grout compressive strength reaches 70 kg/cm² or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.
- D Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the recommended temperature range.
- E Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.
- F Reflect all existing underlying expansion, control and construction joints through the grout.

3.03 INSTALLATION - CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

- A Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Engineer.

- B Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
- C Placements greater than 75 mm depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.
- D Place grout into the designated areas in a manner which will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner which will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- E Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.
- F Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise approved by the Engineer. Finish this surface with a wood float (brush) finish.
- G Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION - NONSHRINK EPOXY GROUTS

- A Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.
- B Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 16 or above 32 degrees C.
- C Place grout into the designated areas in a manner which will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.

- E Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- F Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.05 INSTALLATION - CONCRETE GROUT

- A Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of concrete grout.
- B Remove the debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Wash the tank slab using a strong jet of water. Flushing of debris into tank drain lines will not be permitted.
- C Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Saturation may be maintained by ponding, by the use of soaker hoses, or by other methods acceptable to the Engineer. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1.6 mm to 3.0 mm thick cement paste. A bonding grout composed of 1 part Portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.
- D Provide grout control joints as indicated on the Drawings.
- E Finish and cure the concrete grout as specified for cast-in-place concrete.

3.06 SCHEDULE

The following list indicates where the particular types of grout are to be used:

- A General purpose nonshrink cementitious grout: Use at all locations where non shrink grout is called for on the plans except for base plates greater in area than 1.0 meter wide by 1.0 meter long.
- B Flowable nonshrink cementitious grout: Use under all base plates greater in area than 1.0 meter by 1.0 meter. Use at all locations indicated to receive flowable nonshrink grout by the Drawings. The Contractor, at his/her option and convenience, may also substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.
- C Nonshrink epoxy grout: Use for all locations specifically indicated to receive epoxy grout.
- D Cement grout: Cement grout may be used for grouting of incidental base plates for structural and miscellaneous steel such as post base plates for platforms, base plates for

beams, etc. It shall not be used when nonshrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.

END OF SECTION

SECTION 04200

MASONRY

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required to construct all masonry work as shown on the Drawings and as specified herein.
- B The work under this Section includes, but is not necessarily limited to, the following:
 - 1. Concrete masonry units (CMU)
 - 2. Masonry reinforcing ties and anchors and installation only of CMU lintel reinforcing in masonry
 - 3. Insulation in masonry
 - 4. Grouting as specified herein

1.02 RELATED WORK

- A Masonry in manholes is included in Division 2.
- B Architectural precast concrete is included in Division 3.
- C Grouting of baseplates and equipment is included in Division 3.
- E Miscellaneous Metals is included in Section 05500.
- F Joint Sealants, Caulking, and Flashing is included in Section 07005.

1.03 SUBMITTALS

- A Submit to the Engineer for review, in accordance with Section 01300, complete shop drawings, working drawings and product data for all materials furnished under this Section.
- B Submit certified copies of the reports of all tests specified herein. Test reports shall be accompanied by notarized certificates from the manufacturer certifying that the tested material is of the same type, quality, manufacture and make as that proposed to be supplied.
- C Submit to the Engineer for approval test reports prior to beginning any CMU masonry construction. Tests shall be as follows:
 - 1. Masonry units shall be tested in accordance with procedures of ASTM C140 which indicates compressive strength, absorption, unit weight and net area. Three units shall be tested and averaged.

2. Grout for filled masonry cells shall be tested in accordance with ASTM C39 requirements.
- D Required samples shall be submitted to the Engineer for review sufficiently in advance of time of their installation for investigation and re-submittal of new samples if the preceding sample is found to be non-conforming to the contract requirements. Samples of the following shall be submitted in sizes and quantities stated:
1. CMU: Two samples of each type.
 2. Reinforcement accessories:
 - a. Anchors and ties: Two each type.
 - b. Wall and horizontal joint reinforcement: Two each, minimum length of 40cm.
- E Before each type of masonry work is begun, a sample panel shall be provided for Engineer's approval. The panel shall be approximately 1.80m long, 1.20m high and of the same construction as the walls shown for the building. One face shall show the workmanship, coursing, bond, thickness and tooling of joints, range of color and texture of the masonry and the color of the mortar, all of which shall be as specified. The finished work shall match the sample panel. The panel shall be erected in a location as designated by the Engineer and when directed, shall be completely removed from the job site.

1.04 REFERENCE STANDARDS

A American Society for Testing and Materials (ASTM)

1. ASTM A82 - Standard Specification for Steel Wire, Plain for Concrete Reinforcement.
2. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. ASTM C33 - Standard Specification for Concrete Aggregates.
4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
5. ASTM C90 - Standard Specification for Load-Bearing Concrete Masonry Units.
6. ASTM C129 - Standard Specification for Non-Load-Bearing Concrete Masonry Units.
7. ASTM C140 - Standard Method of Sampling and Testing Concrete Masonry Units.
8. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
9. ASTM C150 - Standard Specification for Portland Cement.
10. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.

11. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
12. ASTM C426 - Standard Test Method for Drying Shrinkage of Concrete Block.
13. ASTM C476 - Standard Specification for Grout for Masonry.
14. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.
15. ASTM E447 - Standard Test Method for Compressive Strength of Masonry Prisms.

B Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 DELIVERY, STORAGE AND HANDLING

A All perishable materials for the work of this Section shall be delivered, stored and handled so as to preclude damage of any nature. Manufactured materials, such as cement and lime, shall be delivered and stored in their original containers, plainly marked with identification of material and maker. Materials in broken containers, or in packages showing water marks or other evidence of damage, shall not be used and shall be removed from the site.

B All CMU masonry shall be shipped stacked with suitable protective devices and shall be stacked off the ground on the site. In addition, all masonry stored on the site shall be protected from the weather and staining with the use of tarpaulins or other covering approved by the Engineer.

1.06 COLD WEATHER CONSTRUCTION

A Masonry construction in cold weather shall conform to the applicable requirements of Brick Industries of America, Technical Bulletin 1A, unless otherwise specified herein. Heat and enclosures will be the only protection methods allowed. No mortar additives shall be used for this purpose.

1.07 HOT WEATHER CONSTRUCTION

A During hot weather conditions, when the ambient temperature is 35 degrees C and above, or when hot wind prevails that may have a rapid drying effect on the freshly constructed masonry, comply with the applicable requirements for hot weather conditions as specified in Section 03300.

B Cure unit masonry construction, complying with the minimum periods specified herein below.

PART 2: PRODUCTS

2.01 MATERIALS - CONCRETE MASONRY

A Concrete masonry units (CMU)

1. CMU shall conform to ASTM C90, Light Weight Grade N-I, hollow, load bearing units of 200mm by 400mm nominal face size and bed dimension as shown on the Drawings. The tolerance in dimensions shall be 3mm in length and height and 1.5mm in width.
2. CMU shall be free from substances that will cause staining or pop-outs and shall be fine, even texture with straight and true edges. All units shall have been wet cured for at least 7 days and then air cured for at least twenty-eight days in covered storage before delivery.
3. Units shall be obtained from one manufacturer to ensure even color and texture.

B Units shall be wet cured, solid or hollow, load-bearing concrete masonry, conforming to ASTM C90 normal weight, Grade N-I. The blocks used shall be manufactured using a vibrating pressure machine.

1. Cementitious and pozzolanic (or siliceous) materials, admixtures and normal weight aggregates shall conform to pertinent ASTM Specifications and shall be suitable for use in autoclaved concrete.
2. Compressive Strength: The strength of blocks when tested in accordance with the British Standards shall have a compressive strength not less than 30kg/cm² and the average compressive strength of ten blocks tested shall be 35kg/cm². Units will be selected at random by the Engineer for testing before and after blocks have been delivered to the job site.
3. Hollow Blocks : The cross-sectional area of the voids in hollow blocks shall not exceed 40% of the total cross-sectional area.
4. Maximum moisture content, shall be (60 to 40) kg/m³, for an average oven-dry density of (2000 to 2400) kg/m³.
5. Surface texture and aggregate exposure shall be as represented by a protected sample wall panel, erected at the job site.
 - a. All masonry units shall be sound and free of cracks or other defects that would interfere with the proper placing of the units or impair the strength or permanence of the construction.
 - b. Minor cracks or defects incidental to the usual method of manufacture, or minor chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection except that not more than 5 percent of a shipment shall contain chips larger than 6mm at any edge or corner on the faces.
6. Concrete Masonry Units shall be delivered to the job site packaged in a manner, so as to prevent damage to the faces in shipment.

- D Insulation for cavity walls shall be extruded closed cell polystyrene foam board with integral high density skins of the same material. Thickness shall be as shown. Insulation shall have a K factor of 0.20 at 24 degrees C and 0.18 at 4 degrees C. Density shall be 33.6 kg/m³ with a compressive strength of 2.81kg/cm². Water absorption shall be 0.7 percent with a water vapor transmission of 0.6 perm-inch. Provide approved asphalt emulsion compatible with insulation for adhering the foam board to backup material. Asphaltic emulsion is specified in Section 07005.
- E Dampproofing for steel-embedded in masonry shall be the same material as the dampproofing specified in Section 07005.

2.02 REINFORCING, TIES, ANCHORS AND MISCELLANEOUS

- A Reinforcement shall be welded wire units prefabricated in straight lengths of not less than 3m with matching corner and tee units fabricated from cold-drawn steel wire complying with ASTM A82, with deformed continuous side rods and plain cross-rods, crimped for cavity wall construction, if required, and a unit width of 40mm to 50mm less than thickness of wall or partition. Units shall be galvanized after fabrication conforming to ASTM A153, Class B-2, 460g/m².
- B Single wythe masonry reinforcement shall be truss type, fabricated with single pair of galvanized 9 gauge side rods and continuous 9 gauge diagonal cross-rods spaced not more than 40cm o.c.
- C Cavity wall reinforcement shall be tab type, fabricated with single pair of 9 gauge side rods and rectangular box type cross-ties with center wall drip spaced not more than 40cm o.c. Space side rods for embedment in each face of back-up wythe and extend box ties for proper embedment in facing wythe.
- D Reinforcement shall be manufactured by Dur-O-Wal; Hohmann and Barnard; AA Wire Products, or approved equal.
- E Galvanized dove-tailed anchor slots shall be furnished for anchorage to concrete framework, walls or ceilings. Anchor slots shall be furnished with polystyrene fillers. Sizes are to be coordinated with the anchors used.
- F Approved 16 gauge corrugated non-ferrous metal ties manufactured for use with the anchor slots provided shall be spaced at maximum of 20cm o.c. vertically and in each anchor slot.
- G Masonry Straps shall be 6.5mm by 25.5mm by the required length. Straps shall be made from hot-dipped galvanized steel. Straps shall be Heckman Building Products No. 273, or approved equal.
- H Weld on adjustable anchors and ties shall be 6.5mm diameter hot-dipped galvanized steel. Anchors shall be Heckman Building Products No. 315, or approved equal. Triangular ties shall be Heckmann Building Products No. 316, or approved equal. Web ties shall be 30cm long by a width for the wall where it is used. Heckmann Building Products No. 318, or approved equal.

- I Provide and install miscellaneous anchors and attachment members, required both for the anchorage of work of this Section and that of other trades requiring attachment to masonry, which are not specifically provided under separate Sections.
- J Compressible filler shall be foamed polyurethane strip saturated with polybutylene waterproofing material. When compressed to 50 percent of its original volume, filler shall hold a head of 1.8m of water and a head of 3m of water when compressed 60 percent. Filler shall maintain its resiliency to allow for installation in temperatures as low as 4 degrees C. Filler shall remain waterproof at 50 percent compression between temperatures of minus 40 degrees C and 93 degrees C. Elongation shall be at least 325 percent with a tensile strength of not less than 3.75kg/cm². The polybutylene compound shall not migrate in the polyurethane strip. Compressible filler shall be Polytite by Sandell Manufacturing Company; Combriband by Secoa Corporation, Division of Phoenix Building Products, Inc., or approved equal.

2.03 MORTAR AND GROUT MATERIALS

- A Ordinary Portland cement shall conform to ASTM C150. Masonry cements shall NOT be used.
- B Sand shall be clean, durable particles, free from injurious amounts of organic matter. The sand shall conform to the limits of ASTM C144. Sand for grout shall conform to ASTM C144 or C33 as required.
- C Water shall be free from injurious amounts of oils, acids, alkalis or organic matter and shall be clean and fresh.
- D Non-shrink grout shall be Masterflow 713 as manufactured by the Master Builders Company; Euco N-S by Euclid Chemical Co.; Five Star Grout by U.S. Grout Corporation, or approved equal. Grout shall attain a twenty-eight day compressive strength of 480 kg/cm².
- E High bond mortar shall be used at the head and sill of all masonry openings and the top two courses of all walls. Mortar shall contain a latex bonding agent, Daraweld-C by W.R. Grace & Co., or equal.

2.04 MORTAR AND GROUT MIXES

- A Ingredients shall be accurately measured by volume in boxes especially constructed for the purpose. Measurement by shovel will not be allowed. Measure materials in a loose condition.
- B Provide test data as required to substantiate Portland cement strength requirements of 125 kg/cm² at twenty-eight days.
- C Mortar proportions shall conform to ASTM C476, Type PM, or as otherwise approved by the Engineer.
- D Non-shrink grout where required shall be mixed as recommended by the manufacturer to give the necessary consistency for placing and to give a minimum compressive strength of 210 kg/cm² in three days.

E All grout shall be 1 part Portland cement, 1 part sand.

PART 3: EXECUTION

3.01 QUALITY CONTROL

- A Samples for testing shall be selected by the Engineer at the place of manufacture from lots ready for delivery. At least ten days should be allowed for completion of the tests, except that a minimum of twenty-one days should be allowed for completion of drying shrinkage tests when required.
1. Drying shrinkage tests shall be conducted upon units made with concrete mixtures having the same proportions and composition, and made and cured in the same way as those specified herein, not more than twelve months prior to delivery of units.
- B In case the shipment fails to conform to the specified requirements, the manufacturer may sort it and new specimens shall be selected by the Engineer from the retained lot and tested at the expense of the manufacturer. In case the second set of specimens fails to conform to the test requirements, the entire lot shall be rejected.
- C The expense of inspection and testing shall be borne by the manufacturer.

3.02 MORTAR

- A Mortar shall be machine mixed in an approved type of mixer in which the quantity of water can be accurately and uniformly controlled. The mixing time shall not be less than five minutes, approximately two minutes of which shall be for mixing the dry materials and not less than three minutes for continuing the mixing after the water has been added. Where the dry-mix method is employed, the materials for each batch shall be well turned over together until the even color of the mixed, dry materials indicates that the cementitious material has been thoroughly distributed throughout the mass, after which the water shall be gradually added until a thoroughly mixed mortar of the required plasticity is obtained.

An air entraining admixture may be used, if permitted by the Engineer, in accordance with the requirements of ASTM C 260. Tests for water retention and compressive strength of mortar shall comply with the applicable requirements of ASTM C 270, Proportion Specification.

- B Mortar boxes shall be cleaned out at the end of each day's work and all tools shall be kept clean. Mortar that has begun to set shall not be used.

3.03 MASONRY INSTALLATION - GENERAL

- A No material that is frozen or covered with frost or snow shall be used in the construction, and no antifreeze salts or ingredients shall be mixed with the mortar. Masonry shall not be laid at temperatures below 4 degrees C, or above 35 degrees C, without the approval of the Engineer and all work shall be done in such a manner as to ensure the proper and normal hardening of all mortar. All masonry work shall be so protected and heated/cooled that the

temperature at the surface will not fall below 10 degrees C or rise above 35 degrees C for a period of seventy-two hours after placing. Any completed work found to be affected by freezing/rapid drying shall be taken down and rebuilt at no expense to the Owner.

- B All masonry shall be laid in a full bed of mortar, applied to shells only. Butter the vertical joint of unit already set in the wall and all contact faces of the unit to be set. Each unit shall be placed and shoved against the unit previously laid so as to produce a well-compacted vertical mortar joint for the full shell thickness.
- C Joints of all masonry shall be tooled in accordance with the following:
1. Wait until unit mortar is thumb-print hard before tooling joint. This may require as much as three hours in the shade and one hour in the sun in the summertime.
 2. The required personnel shall be kept on the job after hours, if necessary, to properly tool joints.
- D Install all frames required to be set in masonry, set masonry tightly against frames, build in all frame anchors and fill frames with mortar.
- E All masonry slots, chases, or openings required for the proper installation of the work of other Sections shall be constructed as indicated on the Drawings or in accordance with information furnished before the work is started at the points affected. No chase shall cut into any wall constructed of hollow units after it is built, except as directed and approved by the Engineer.
- F Surfaces shall be brushed as work progresses and maintained as clean as it is practicable. Unfinished work shall be raked back where possible, and toothed only where absolutely necessary. Before leaving fresh or unfinished work, walls shall be fully covered and protected against adverse weather conditions which may affect the proper and timely setting of the work, including rain, wind and direct hot sun rays, and before continuing, work previously laid shall be swept clean. The tops of walls or other unfinished work shall be protected against all damage by frost, rain, direct hot sun rays or the elements by means approved by the Engineer.
- G Cavity wall insulation shall be installed in walls, where shown, in accordance with the manufacturer's recommendations as approved. Fix insulation boards to internal leaf of cavity wall masonry by means of PVC fasteners, anchor fasteners in mortar, coordinate placing of insulation with installation of masonry wall reinforcing. Exterior walls shall not receive insulation when the temperature is below 4 degrees C.
- H Build in all miscellaneous items to be set in masonry for which placement is not specifically provided under separate Divisions, including reglets, lintels, ties, electrical panel boxes, process equipment, sleeves, vents, grilles, anchors, grounds and exterior electric conduits and fixtures and cooperate with other trades whose work is to be coordinated with the work under this Section.
- I All anchorage, attachment and bonding devices shall be set so as to prevent slippage and shall be completely covered with mortar or grout.

- J All ties and reinforcing for masonry shall be furnished and installed under this Section. Horizontal reinforcement shall be installed continuously in every other course or 40cm on center vertically.
- K Build in and grout fully all seismic wall reinforcing as shown.
- L Lintels shall be furnished under Division 3 and installed under this Section.
- M Lintels shall be set in a full bed of mortar and supported by mortar filled hollow CMU as detailed.
- N Bed and grout for items coming in contact with masonry where grouting is required, including, but not limited to, door frames set in masonry. Install all anchor bolts, base plates and seats in masonry walls and build in all items required for the completion of the building as they apply to masonry.
- P Dampproof steel embedded in masonry according to general installation for dampproofing cavity walls.

3.04 CMU MASONRY INSTALLATION

- A Units shall be laid in mortar and set with all cells in a vertical position. The moisture content of the units when laid shall not exceed 35 percent of the total absorption as determined by laboratory test.
- B CMU shall be laid in running bond, with full stretchers, unless otherwise shown. Tool joints dense and neat. Exercise extreme care to maintain vertical joints in soldier coursing exactly vertical.
- C Wetting the CMU units by full immersion in water shall not be permitted. During hot dry weather conditions (as specified above), the surface only shall be wetted using light fog spray.
- D Sizes shall be as specified and called for on the Drawings.
- E CMU Joints shall be tooled in compliance with the requirements of 3.03 C above and with the following:
 - 1. Both vertical and horizontal joints shall be maintained uniform in spacing.
 - 2. Joints for all types of CMU shall be 10 mm and concave.

3.05 BONDING AND ANCHORING

- A Unless otherwise shown, corners and intersections of load-bearing masonry walls shall be bonded in each course with a true masonry bond, except that when necessarily erected separately, they shall be anchored with rigid steel anchors spaced not more than 60cm apart vertically.

- B Intersections of non-load-bearing partitions with other walls or partitions shall be tied with corrugated metal anchors at vertical intervals of not more than 5 m, or with masonry bonding in alternate courses.
- C Masonry walls facing or abutting concrete members shall be anchored to the concrete with dovetail or wire type anchors inserted in slots or inserts built into the concrete. Anchors shall be spaced not more than 40cm on centers vertically and not more than 60cm on centers horizontally.

3.06 REINFORCED MASONRY

- A Provide reinforcing in filled cores and bond beams of masonry units of size, spacing and locations as indicated on the Drawings and as specified herein.
- B Reinforced Concrete Masonry Unit Walls shall be laid in such a manner as to preserve the unobstructed vertical continuity of cells to be filled. Cross webs adjacent to vertical cores that are to be filled with grout shall be fully embedded in mortar, to prevent leakage of grout. Mortar fins protruding from joints shall be removed before grout is placed; the minimum clear dimensions of vertical cores shall be 50mm by 75mm. Reinforcing shall be positioned accurately as indicated. As masonry work progresses, vertical reinforcing shall be rigidly secured in place at vertical intervals not to exceed 160 bar diameters. Horizontal reinforcing shall be embedded in grout as grouting proceeds. The minimum clear distance between masonry and vertical reinforcement shall be not less than 13mm. Unless indicated or specified otherwise, splices shall be formed by lapping bars not less than 30 bar diameters and wire tying them together. Maximum height of masonry walls prior to grouting shall be 120cm.
- C Grouting of filled cells shall be performed in accordance with standard high-lift grouting procedures. Grout shall contain sufficient water to be of pouring consistency and sufficiently fluid to flow into joints and around reinforcing without leaving voids. Grout shall be well stirred before placing to avoid segregation of the aggregate and shall be placed by pumping; or pouring from chutes, buckets with spouts, or other spouted containers. The maximum height of grout pour for concrete masonry shall be 120cm. Grout shall be rodded or agitated thoroughly to eliminate voids but with caution not to displace masonry from its original position nor to stain exposed surfaces. Masonry displaced by grouting shall be removed and laid in realignment with fresh mortar.

Pours shall be kept at 4cm below the top of masonry units in the top course, except for the finish course. Each pouring of grout shall be rerodded or otherwise reagitated one to 1-1/2 hours after placing.

3.07 REPAIR, POINTING AND FINAL CLEANING

- A Exposed masonry shall be protected against staining by wall coverings and excess mortar shall be wiped off the surface as the work progresses to reduce need for cleaning at completion of the work.
- B Where ordered, remove masonry units which are loose, chipped, broken, stained or otherwise damaged and units which do not match adjoining units and install new units in

fresh mortar or grout, pointed to eliminate, as approved by the Employer, evidence of replacement.

C Pointing

1. During the tooling of joints, enlarge any voids or holes and completely fill with mortar matching color as approved by the Engineer and tool to match. Point-up all joints at corners, openings and adjacent work to provide a neat, uniform appearance and properly prepare joints for application of sealants where required.
2. Before final cleaning, repoint all unsatisfactory joints as specified above and as required by the Engineer.

D Final Cleaning of Masonry

1. After mortar has thoroughly set and cured (three weeks minimum during the summer; five weeks minimum during the winter), a sample wall area (approximately 2 m²), shall be cleaned, with an approved commercial masonry cleaner, diluted and mixed with water as recommended by the manufacturer and as approved. The sample area may be the sample wall panel specified above or an area in the finished work as ordered by the Engineer.
2. The Engineer's acceptance of sample cleaning shall be obtained before proceeding to clean remainder of masonry work. A minimum of one week of dry weather is required to evaluate effectiveness of cleaning and effect on masonry and mortar. Upon approval by the Engineer, all masonry shall be cleaned by the same method to the satisfaction of the Engineer.

E Acid solutions shall not be used for cleaning any CMU. Upon completion of the work, all surfaces of CMU shall be washed with soap powder and warm water, applied with a scrubbing brush and then rinsed thoroughly with clear water. Other cleaning methods may be ordered to obtain required appearance.

F Masonry areas not satisfactorily cleanable will be ordered to be replaced at no extra cost to the Employer.

END OF SECTION

SECTION 05500

MISCELLANEOUS METALS

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required to complete and install fabricated metal items. Furnish all supplementary items necessary for their proper installation.
- B Check Drawings carefully and furnish all anchors, sleeves, bolts, brackets, clips, inserts, angles, loose lintels, tubing, bar stock, plates and other miscellaneous metal not distinctly specified under other sections but necessary to complete the Work.

1.02 RELATED WORK

- A Metal concrete accessories are included in Section 03250.
- B Masonry reinforcement, ties and accessories are included in Section 04200.
- C Aluminum and metal ladders are included in Section 05515.
- D Metal grating and cover plates are included in Section 05530.
- E Galvanizing is included in Section 05910.
- F Pipe hangers, supports and concrete inserts are included under Division 15.

1.04 REFERENCE STANDARDS

- A Aluminum Association (AA)
 - 1. ASD-1 Aluminum Standards and Data.
 - 2. Specifications for Aluminum Structures.
- B American Institute of Steel Construction (AISC)
 - 1. Manual of Steel Construction, Eighth Edition
 - 2. Manual of Steel Construction - Load & Resistance Factor Design, First Edition
- C American Society for Testing & Materials (ASTM)
 - 1. ASTM A36 - Standard Specification for Structural Steel.
 - 2. ASTM A48 - Standard Specification for Gray Iron Castings.

3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
4. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
5. ASTM A120 - Standard Specification for Zinc (Hot-Dip Galvanized) Steel Pipes.
6. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
7. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
8. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
9. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Services.
10. ASTM A276 - Standard Specification for Stainless Steel and Heat-Resisting Steel Bars and Shapes.
11. ASTM A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
12. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
13. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
14. ASTM A366 - Standard Specification for Steel, Sheet, Carbon, Cold-Rolled Commercial Quality.
15. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
16. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
17. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
18. ASTM F436 - Standard Specification for Hardened Steel Washers.
19. ASTM F594 - Standard Specification for Stainless Steel Nuts.

D American Iron and Steel Institute (AISI)

E American National Standards Institute (ANSI)

1. ANSI B18.22.1 - Lock Washers.

F American Welding Society (AWS)

1. AWS D1.1 Structural Welding Code - Steel
2. AWS D1.2 Structural Welding Code - Aluminum
3. AWS A2.0 Standard Welding Symbols

G Steel Structures Painting Council (SSPC)

1. SSPC SP-1 - Surface Preparation Specification No.1 "Solvent Cleaning"
2. SSPC SP-2 - Surface Preparation Specification No.2 "Hand Tool Cleaning"
3. SSPC SP-3 - Surface Preparation Specification No.3 "Power Tool Cleaning"
4. SSPC SP-6 - Surface Preparation Specification No.6 "Commercial Blast Cleaning"
5. SSPC SP-10 - Surface Preparation Specification No.10 "Near-White Blast Cleaning"

H Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SUBMITTALS

- A Prior to fabrication, submit shop drawings, erection or setting drawings, product data, etc., showing methods of assembly, anchorage and connection to other members. Indicate welded connections in accordance with AWS A2.0. Shop drawings will be required for all items included under this Section.
- B Submit samples as requested by the Engineer during the course of construction.

1.05 COORDINATION

- A Coordinate completely the Work of this Section with the Work of other Sections. Verify at the site both the dimensions and Work of other trades adjoining items of work in this Section before fabrication and installation of the items specified.
- B Take field measurements at the site to confirm and/or supplement indicated dimensions and to ensure proper fit of all components.
- C Furnish to the appropriate trades all items specified under this Section and installed under other Sections.

1.06 DELIVERY, STORAGE AND HANDLING

- A Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.
- B Deliver anchorage devices with setting drawings, templates and instructions for installation.
- C Store delivered items off the ground and protected from dirt and weather.
- D Repair items which have become damaged or corroded to the satisfaction of the Engineer prior to incorporating them into the Work.

PART 2: PRODUCTS

2.01 STEEL FABRICATIONS

A Materials

1. Structural steel shapes, plates, bars and rods ASTM A36
2. Steel plates - bent or cold-formed ASTM A283, Grade C
3. Steel sheets ASTM A366
4. Welded and seamless steel pipe ASTM A501 or ASTM A53, Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work
5. Welded and seamless rectangular steel tubing ASTM A500, Grade B
6. Carbon steel bolts and studs, ASTM A307, Grade A, hot-dip galvanized nuts and washers where noted
7. High strength bolts, nuts and ASTM A325, hot-dip galvanized washers for structural steel where noted
 - elevated temperature exposures ASTM A325-Type I
 - general application ASTM A325-Type I or II
8. Headed Anchor Studs Nelson Type H4L or S3L by Nelson Stud Welding Company, or equal
9. Welding Materials AWS D1.1
10. Galvanizing as specified in Section 05910.
11. Shop and Touch-up Primer SSPC 15 Type I red oxide

2.02 CAST IRON FABRICATIONS

A Materials

1. Gray iron castings ASTM A48, Class 30.

B Fabrication

1. See general fabrication requirements in Paragraph 2.05.
2. Provide frames, covers and grates for manholes, catch basins and inlets fabricated from good quality, strong, tough, even grained cast iron. Castings shall be as manufactured by the Neenah Foundry; Mechanics Iron Foundry or equal. Sizes shall be as shown on the Drawings or specified. Covers shall have letters "WATER", "SEWER" or "DRAIN", as applicable, embossed on top.
3. Provide solid manhole and holdhole covers and frames for electrical and telephone underground systems. Covers shall have letters "HIGH VOLTAGE", "LOW VOLTAGE" "SIGNAL", "TELEPHONE", as applicable, embossed on top.

2.03 ALUMINUM FABRICATIONS

A Aluminum Framing and Fabrications

1. Materials

- a. Aluminum structural shapes and plates. Alloy 6061-T6
- b. Extruded aluminum pipe. Alloy 6063-T6
- c. Fasteners. Stainless Steel ASTM A276, Type 316

2. Fabrication

- a. See general fabrication requirements in Paragraph 2.05.
- b. Fabricate miscellaneous aluminum shapes and plates as shown. Furnish welded and mitered angle frames and other fabrications complete with welded anchors attached. Furnish all miscellaneous aluminum shown but not otherwise detailed. Structural shapes and extruded items shall comply with the dimensions on the Drawings within the tolerances published by the Aluminum Association.
- c. Weld aluminum work on the unexposed side when possible in order to prevent pitting or discoloration of exposed aluminum surfaces.

3. Finishes

- a. All exposed aluminum surfaces shall have fabricator's standard mill finish unless otherwise specified. Apply a coat of methacrylate lacquer to all aluminum before shipment.

2.04 ANCHORS, BOLTS AND FASTENING DEVICES

- A Furnish anchors, bolts, fasteners, etc, as necessary for installation of the Work of this Section or for securing the Work of other Sections to in-place construction.
- B Compound masonry anchors shall be of the type shown or required and shall be equal to Star Slug in compounded masonry anchors manufactured by Star Expansion industries; Phillips Drill Co., Rahlplug or equal. Anchors shall be minimum "Two unit" type.
- C The bolts used to attach the various members to the anchors shall be the sizes shown or required. Attach aluminum to concrete or masonry by means of stainless steel machine bolts. Attach iron or steel with steel machine bolts unless otherwise specifically noted.
- D For structural purposes, unless otherwise noted, drilled concrete anchors shall be adhesive capsule type or expansion type anchor bolts.
1. Adhesive capsule anchors shall be a two-part stud and capsule chemical resin anchoring system. Capsules shall be self-contained, exactly proportioned, sealed glass units containing premeasured amounts of resin, aggregates and hardener. Stud assemblies shall be as indicated on the Drawings and shall include all-thread anchor rod with nut and washer, or deformed reinforcing steel complying with the requirements of Section 03200. Provide manufacturer's recommended drive units and adaptors for installing capsules and studs. Install anchors in full compliance with the manufacturer's recommendations.
 - a. Threaded anchor rod assemblies shown on the Drawings shall be manufactured from the following materials:

I.	Standard:	Rod:	ASTM A307, Grade A
		Nut:	ASTM A563, Grade A
		Washer:	ANSI B18.22.1, Type A
	Plain		
 - ii. High Strength:

Rod:	ASTM A193, Grade B7
Nut:	ASTM A563, Grade DH
Washer:	ASTM F436
 - iii. Stainless Steel:

Rod:	ASTM F594 (AISI Type 304)
Nut:	ASTM F594
Washer:	ANSI B18.22.1, Type A,
	Plain
 - b. Examples of acceptable manufacturers are Hilti "HVA Adhesive Anchor", Molly "Parabond Capsule Anchor", or approved equal.
2. Expansion Anchors shall be drop-in wedge type anchors of the sizes noted on the Drawings complete with nuts and washers. Unless otherwise noted, provide zinc plated carbon steel anchors. Stainless steel anchors, where required shall be all AISI Type 316 construction. When the length or embedment of the bolt is not noted on the

Drawings, provide length sufficient to place the wedge and expansion sleeve portion of the bolt at least one inch behind the reinforcing steel within the concrete. Examples of acceptable manufactures are Hilti: "Kwik Bolt", Molly: "Parabolt", or approved equal.

- E Headed anchor studs shall be flux ended, welded to plates or other embeds as shown on the Drawings. Studs shall be made from cold drawn steel Grades C-1010 through C-1020 per ASTM A108 and shall be welded per the manufacturer's recommendations. Examples of acceptable manufacturers include Nelson Stud Welding Company, Loraine, OH - Type H4L or S3L, or approved equal.

2.05 FABRICATION - GENERAL

- A Form all miscellaneous metal work true to detail, with clean, straight, sharply defined profiles, and smooth surfaces of uniform color and texture. Provide fabrications free from defects impairing strength or durability. Drill or punch holes and smooth edges. Ease exposed edges to a small, uniform radius. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B Supply components required for anchorage of fabrications. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.
- C Welded joints shall be rigid and continuously welded or spot welded as specified or shown. Dress the face of welds flush and smooth. Continuously weld and grind smooth welds that will be exposed. Exposed joints shall be close fitting and jointed where least conspicuous. Conceal fastenings where practical. Punch or drill for temporary field connections and for attachment of the Work of other trades.
- D Welding of parts shall be in compliance with the latest edition of the AWS structural welding code for steel (D1.1) or aluminum (D1.2) as appropriate, and shall only be done where shown, specified, or permitted by the Engineer. Welding shall be performed only by welders certified to perform the required welding in compliance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.
- E Castings shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Thoroughly clean castings. Castings may be subjected to a hammer inspection in the field by the Engineer. All finished surfaces shown on the Drawings and/or specified shall be machined to a true plane surface allowing pieces to sit at all points without rocking. Make allowances in the patterns so that thicknesses specified or shown will not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from the dimensions shown. Provide facilities for weighing castings in the presence of the Engineer and show true weights, certified by the supplier.

- F Shop painting will not be required for galvanized metal, aluminum, copper, brass and bronze unless specifically specified.

PART 3: EXECUTION

3.01 INSTALLATION - GENERAL

- A Install all items furnished except items to be embedded in concrete or masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in compliance with the details shown. Furnish to appropriate trades all anchors, sockets, or fastenings required for securing Work to other construction.
- B Set metal work level, true to line and plumb as indicated, accurately fitted, free from distortion or defects and securely anchored to the structure.
- C Weld field connections and grind smooth where practicable. Clean and strip primed, steel items to bare metal where site welding is required. Conceal fastenings where practicable.
- D Secure metal to wood with lag screws, of adequate size, with appropriate washers.
- E Secure metal to masonry with embedded anchors, setting compound, lead calking and sleeves, or cement-sand grouting. Fastening to wood plugs in masonry will not be permitted.
- F Touch-up abrasions to finish or primer coatings immediately after erection and prior to both final coating and final acceptance.
- G Break contact between dissimilar metals as shown on the Drawings or as specified in Paragraph 3.01H.
- H Field-apply coatings for installation of metal fabrications according to the following schedule. For embedded items, coat the embed.
 1. All steel surfaces in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in compliance with the manufacturer's instructions prior to installation.
 2. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
 3. Where aluminum contacts masonry or concrete, apply a heavy coat of zinc chromate primer to the surface of the aluminum.
 4. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

3.02 DETAILS OF FABRICATED METAL ITEMS

- A Steel Door Framing. Galvanized steel of size and shape indicated with adjustable anchors. Miter corner connections, weld and grind smooth. Fabricate frames with not less than three anchors per jamb.
- B Aluminum Door Framing. Structural aluminum angle and channel shapes of sizes indicated with adjustable anchors. Miter corner connections weld and grind smooth. Fabricate frames with not less than three anchors per jamb.
- C Steel Angle Stiffener for oversize Hollow Metal Door Jambs. Galvanized steel angle of size indicated or required to adequately support hollow metal door. Continuous from floor slab to structure above.
- D Steel Supports and Frames for Louvers. Galvanized structural steel of size and shape indicated or as required for windloads.
- E Coiling Door Track Supports. Galvanized structural steel angles and anchor bolts as indicated.
- F Expansion Joint Angles. Structural steel angles as indicated with continuous 0.64cm bars welded to angle face for neoprene seal stop. Galvanize all members and verify location of stop with neoprene seal manufacturer.
- G Partition Supports. Galvanized structural steel angles of size and shape indicated.
- H Ceiling Mounted Equipment Supports. Galvanized structural steel as indicated.
- I Steel Pipe Handrails and Guardrails. Welded Galvanized steel pipe.
- J Steel Pipe Guard Post (Bollards). Galvanized steel pipe as indicated, fill with concrete to formed crowned cap.
- K Wall Sleeves. Galvanized (Schedule 40) steel or cast iron pipe with end joints as shown on the Drawings. Provide center anchor around circumference as shown.
- L Bolts, Anchors, Brackets, Clips and Inserts. Type and size required to rigidly secure members for which they are to be used.
- M Miscellaneous Angles, Plates, Gratings, Tubing, Bar Stock, Break Metal, Etc. As required for the proper installation of various items throughout the building if not otherwise furnished.
- N Steel Angle Corner Protection. Galvanized steel of the size and shape indicated.

END OF SECTION

SECTION 05530

METAL GRATINGS, COVER PLATES, AND ACCESS HATCHES

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required to install metal gratings and floor cover plates along with embedded or attached support frames as shown on the Drawings or as specified herein.

1.02 RELATED WORK

- A Grating or cover plate anchoring devices for attaching these supports to concrete are included in Section 05500.

1.03 SUBMITTALS

- A Submit to the Engineer, for approval before fabrication, detailed Shop Drawings showing sizes of members, method of assembly, anchorage and connection to other members.
- B Submit manufacturer's product data for gratings and plates including span and deflection tables and details of construction.
- C Submit manufacturer's installation instructions.
- D Submit samples 60cm by 60cm in size, illustrating surface finish, color, texture and jointing details.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials:
 - 1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 3. ASTM A569/A569M - Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality.
 - 4. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 5. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- B. American Welding Society:
 - 1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 - 2. AWS D1.1 - Structural Welding Code - Steel.
 - 3. AWS D1.2 - Structural Welding Code - Aluminum.

- C. National Association of Architectural Metal Manufacturers:
 - 1. NAAMM MBG 531 - Metal Bar Grating Manual.
 - 2. NAAMM MBG 532 - Heavy Duty Metal Bar Grating Manual.

- D. SSPC: The Society for Protective Coatings:
 - 1. SSPC - Steel Structures Painting Manual.
 - 2. SSPC SP 1 - Solvent Cleaning.
 - 3. SSPC SP 10 - Near-White Blast Cleaning.
 - 4. SSPC Paint 15 - Steel Joist Shop Paint.
 - 5. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).

- A Aluminum Association
 - 1. Engineering Data for Aluminum Structures (Publication 33)

- B American National Standards Institute (ANSI)
 - 1. ANSI A202.1 - Metal Bars Grating Manual for Steel and Aluminum Grating and Stair Treads.

- C American Society for Testing and Materials (ASTM)
 - 1. ASTM A276 - Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

- D American Welding Society (AWS)
 - 1. AWS D1.2 - Structural Welding Code - Aluminum

- E Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A The work of this Section shall be completely coordinated with the work of other Sections. Verify at the site the dimensions and the work of other trades adjoining items of work in this Section before fabricating or installing the items specified.

- B Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

PART 2: PRODUCTS

2.01 ALUMINUM ACCESS HATCHES FOR VAULTS

- A Aluminum access hatches shall be of the size shown on the Drawings for all reservoirs.

- B Access hatches shall be mill finished with a bituminous coating applied to the exterior of the frame.

- C Channel frame shall be 6.35 mm aluminum with full anchor flange around the perimeter and shall have a minimum cross sectional area of 4839 mm².
- D Hatch aluminum hinges having 7.94 mm minimum diameter stainless steel pins and pivot so that the cover does not protrude into the channel frame.
- E Compression spring operators enclosed I telescopic tubes shall be provided.
- F The hatch shall automatically lock in the vertical position by means of a heavy steel hold-open arm with release handle.
- G A continuous gasket shall be fixed to the frame to form an order resistant barrier.
- H A 316 stainless steel snap lock with a gasketed cover plug and removable turn handle shall be provided.
- J A 38 mm diameter drainage coupling shall be located in the channel frame.
- I Access hatches shall conform to all aspects of the specification. Examples of such access hatches are Bilco Type J-AL-R or approved equal.

2.0201 HOT DIPPED GALVANIZED COVER PLATES

- A Cover plates shall be checker type with a minimum thickness of 6 mm. The checker plate covers shall have a raised figure pattern on one surface to provide improved traction.
- B Plate, frames, and support shall be all hot dipped galvanized steel as shown on the Drawings.
- C Cover plate fastening devices and hardware shall be type 316 stainless steel.
- D Cover plates shall be provided with a hot-dipped galvanized 40 mm x 40 mm x 5 mm stiffener on the bottom side when spanning distances greater than 750 mm.

2.02 FABRICATION

- A Provide work true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture free from defects impairing strength or durability.
- B Field verify dimensions prior to fabrication.
- C Provide connections and accessories of sufficient strength to safely withstand stresses and strains to which they will be subjected. Threaded connections shall be made so that the threads are concealed by fitting.
- D Angle frames and floor plates shall be welded and mitered with welded strap anchors attached.

- E Welded joints shall be rigid and continuously welded or spot welded as specified or shown. Dress the face of welds flush and smooth. Exposed joints shall be close fitting and located where least conspicuous.
- F Welding of parts shall be in compliance with the latest edition of AWS D1.1. Welding only to be done where shown, specified, or permitted by the Engineer. Welding shall be done by welders certified to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.
- G Weld galvanized steel Work on the unexposed side when possible in order to prevent pitting or discoloration.

2.03 SHOP FINISHING

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C Galvanizing: all in accordance with ASTM A653/A653M to G90.

PART 3: EXECUTION

3.01 INSPECTION

- A Verify that opening sizes and dimensional variations are acceptable for installation of grating or cover plates at the specified tolerances. Report any non-complying areas to the Engineer prior to proceeding with installation.

3.02 INSTALLATION

- A Install all items furnished except items to be embedded in concrete which shall be installed under Division 3. Install items to be attached to concrete or masonry after such work is completed and in compliance with the details shown.
- B Field cutting of finished surfaces is not allowed unless specifically approved by the Engineer. When cutting is approved, use mechanical cutting tools; do not use flame cutting tools.
- C Secure cover with fastening devices as specified to prevent movement, except where removable cover is called for on Drawings.
- D Where aluminum contacts a dissimilar metal, field-apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
- E Where aluminum contacts masonry or concrete, field-apply a heavy brush coat of zinc chromate primer to the masonry or concrete. For embedded items, coat the embed.
- F Where aluminum contacts wood, field-apply two coats of aluminum metal and masonry paint to the wood.

G Access hatches shall be installed in accordance with the manufacturer's instructions.

3.03 FIELD QUALITY CONTROL

A TOLERANCES

1. Maximum space between adjoining or abutting sections: 6 mm.
2. Maximum variation from top surface plane of adjoining or abutting sections or structure: 3 mm.

END OF SECTION

SECTION 05910

GALVANIZING

PART 1: GENERAL

1.01 SCOPE OF WORK

A Hot dip galvanizing of structural steel members, assemblies and metal fabrications.

B Definitions

1. Hot Dip Galvanizing: The dipping of steel members and assemblies into molten zinc for long-term corrosion protection. The resultant zinc coating fuses permanently with the base steel material.
2. Electro galvanizing: Electrodepositing or electro-plating with zinc by electrolysis for limited corrosion protection.
3. Passivating: The chemical treatment of freshly galvanized steel materials to prevent humid storage stain (white rust or white corrosion). This treatment (passivation) consists of quenching freshly galvanized steel in water to which a chromate or a chromic-acid solutions, or other proprietary solution, has been added.

1.02 REFERENCE STANDARDS

A American Hot Dip Galvanizers Association, Inc. (AHDGA)

1. Publication, "Inspection Manual for Hot Dip Galvanized Products."

B American Society for Testing and Materials (ASTM)

1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
2. ASTM A123 - Standard Specification Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A143 - Standard Specification Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
4. ASTM A153 - Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
5. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
6. ASTM A384 - Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.

7. ASTM A385 - Standard Practice for Providing High Quality Zinc Coating (Hot-Dip).
8. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
9. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
10. ASTM B6 - Standard Specification for Zinc.
11. ASTM D2092 - Standard Practice for Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting.

C Certification: Furnish Certificates of Compliance with ASTM Specifications and Standards specified herein. Each certificate to be signed by Contractor and Galvanizer certifying that steel materials, bolts, nuts, washers and items of iron and steel hardware conform with specified requirements.

D Inspections and Tests: Inspections, tests and samples to conform with ASTM Specifications and Standards. Inspections rights and privileges, procedures and acceptance or rejection of galvanized steel materials to conform with ASTM A123 or A153, as applicable. Inspections and tests include the following:

1. Visual examination of samples and finished products.
2. Tests to determine weight or mass of zinc coating per square foot of metal surface.
3. Tests to determine distribution and uniformity of zinc coating.

1.03 SUBMITTALS

A Furnish Certificates of Compliance with certified original and two copies forwarded to the Engineer.

1.04 DELIVERY, STORAGE AND HANDLING

A Packaging: Of type to prevent damage to galvanized surfaces and distortion of steel materials and components.

B Handling and Storage: Handle and protect galvanized materials from damage to zinc coating. To avoid humid storage stain, space surfaces of galvanized materials to permit free circulation of air.

C Damaged Material: Repair material showing evidence of damage to zinc coating. If not repairable, material with damaged coating will be subject to rejection.

PART 2: PRODUCTS

2.01 STEEL MATERIALS

- A Material for galvanizing to be geometrically suitable for galvanizing as specified in ASTM A384 and A385. Steel materials suitable for galvanizing include structural shapes, pipe, sheet, fabrications and assemblies.
- B Material to be chemically suitable for galvanizing.

2.02 IRON AND STEEL HARDWARE

- A Bolts, nuts, washers and items of iron and steel hardware furnished or galvanized to be suitable for hot dip galvanizing.
- B Inspect iron and steel hardware before galvanizing and ascertain whether suitable for galvanizing. Replace items which are not suitable for galvanizing.

2.03 ZINC FOR GALVANIZING

- A Conform with ASTM B6, as specified in ASTM A123.

2.04 GALVANIZING

- A Steel members, fabrications and assemblies to be galvanized after fabrication, by hot dip process in accordance with ASTM A123, as applicable. Weight of zinc coating to conform to requirements specified under "Weight of Coating" in ASTM A123, as applicable.
- B Safeguard against steel embrittlement in conformance with ASTM A143.
- C Safeguard against warpage or distortion of steel members to conform with ASTM A384. Notify Engineer of potential warpage problems which may require modification in design, before proceeding with steel fabrications.
- D Finish and uniformity of zinc coating and adherence of coating to conform with ASTM A123 or A153, as applicable.
- E Bolts, nuts and washers, and iron and steel hardware components to be galvanized in accordance with ASTM A153. Weight of zinc coating to conform to requirements specified under "Weight of Coating" in ASTM A153. Nuts to be tapped after galvanizing to minimum diametral amounts specified in ASTM A563. Coat nuts with waterproof lubricant, clean and dry to touch. High strength bolts for structural steel joints to be galvanized in accordance with ASTM A325.

2.05 PASSIVATING

- A Galvanizing materials subject to extended periods of storage in open, exterior locations shall be given passivating treatment or light oiling to prevent humid storage stain. Treatment, solution and process subject to review and acceptance by Engineer. Chromate passivation should not be used on items galvanized after fabrication and are to be painted after erection.

2.06 PRESERVATIVE OILS

- A Do not treat freshly galvanized or passivated surfaces with oils, grease, or chemicals which might interfere with adhesion of subsequent paint primers and coatings.

2.07 PAINTING

- A Prepare galvanized metal surface to be field painted in accordance with ASTM D2092.
- B Shop coat galvanized metal surfaces with approved galvanized primer.

PART 3: EXECUTION

3.01 INSTALLATION OF STEEL MATERIALS

- A Steel materials, fabrications and assemblies are specified to be installed in various other sections under Division 5.

3.02 FIELD INSPECTION

- A Inspect installed galvanized materials, fabrications and assemblies to conform with applicable requirements of AHDGA, consisting of visual inspection.

3.03 TOUCH UP AND REPAIR

- A Repair damaged galvanized surfaces in accordance with ASTM A780.
- B Dry film thickness of applied repair materials to be not less than galvanized coating thickness required by ASTM A53, A123 or A153, as applicable.
- C Touch up prime-painted surface with same galvanized primer applied in shop. Clean damaged surfaces first to assure proper paint adhesion.

END OF SECTION

SECTION 07005

JOINT SEALANTS AND CAULKING

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all materials, labor, equipment, and incidentals required and perform all sealing of joints in structural concrete, all caulking, and all flashing and related work necessary for the proper completion of the project as shown and as specified herein including caulking of sample joints in masonry sample wall.
- B Proceed with joint sealants and caulking work only after substrate construction and penetrating work have been completed and when existing and forecast weather conditions will permit work to be performed in accordance with manufacturer's recommendations.

1.02 RELATED WORK

- A Concrete work is included in Division 3.
- B Masonry work is included in Section 04200.
- C Bituminous Dampproofing is included in Section 07160.

1.03 SUBMITTALS

- A Submit to the Engineer as provided in Section 01300 for shop drawings, detailed information on materials proposed and installation methods.
- B Submit two sets of representative samples of any or all other proposed materials required for the work of this Section as requested by the Engineer.

1.04 APPLICATION SCHEDULE

- A Caulk all exterior wall joints between frames in openings and adjacent steel and masonry materials, between masonry and cast in place concrete, control and expansion joints and all other joints shown or required for the completion of the work.
- B Caulk all interior joints between frames and steel, concrete and masonry, where detailed, between masonry and steel, control joints in tile and all other joints shown or required for the completion of the work.

PART 2: PRODUCTS

2.01 MATERIALS

- A Materials for Caulking and Sealants

1. All colors for caulking above grade in the superstructure of the buildings shall be selected by the Engineer from standard colors. Allow for up to three colors in superstructure caulking.
2. Exterior and interior sealant for joints on the horizontal plane shall be two part, pour grade polyurethane base, Sikaflex 2c SL sealant by Sika, Inc.; Tremco or Sonneborn, or approved equal. Primer shall be as recommended by the manufacturer.
3. Exterior and interior sealant for joints on all other surfaces shall be one part, gun grade, polyurethane base (Sikaflex 1a by Sika) or silicone base (by General Electric or Dow Corning) sealant. Primer shall be as recommended by the manufacturer.
4. Joint backing for joints in superstructure shall be approved closed cell polyethylene rods of diameters to suit joint conditions. Where joint depth will not allow for a rod and still provide 6.25 mm minimum depth of sealant, provide approved bond breaker tape at bottom of joint.

PART 3: EXECUTION

3.01 INSTALLATION

A Installation of Caulking and Sealants

1. All joints to receive sealant shall be cleaned, primed, backed and caulked in complete accordance with the manufacturer's instructions. Provide specified backing rods for all joints or, where authorized, approved bond breaker tape.
2. Sealant shall be applied to a square section configuration. Unless otherwise noted on the Drawings, minimum depth of joint shall be 6 mm and maximum 13 mm. For joints greater than 13 mm wide provide sealant in a 2 to 1 width-to-depth ratio.
3. The surfaces of all materials adjoining caulked joints shall be cleaned free of all smears of sealant or other soiling due to caulking operations.
4. Joints in masonry shall be installed and the exposed face tooled to the depth and configuration of adjoining masonry mortar joints.

3.02 CLEANUP

- A At all times keep the premises free from accumulation of waste materials and rubbish. At the completion of the installation remove all tools, scaffolding and surplus materials and remove all of rubbish from and above the area.
- B Remove all waterproofing, dampproofing and caulking materials from all surfaces where materials are not required to produce a clean, neat, workmanlike job.

END OF SECTION

SECTION 07160

BITUMINOUS DAMPPROOFING

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all materials, labor, equipment, and incidentals required and perform all dampproofing of poured in place concrete and related work necessary for the proper completion of the project as shown and as specified herein.
- B Proceed with dampproofing work only after substrate construction and penetrating work have been completed and when existing and forecast weather conditions will permit work to be performed in accordance with manufacturer's recommendations.

1.02 RELATED WORK

- A Concrete Work is included in Division 3.
- B Masonry Work is included in Division 4.
- C Joint Sealants, Caulking, and Flashing is included in Section 07005.

1.03 SUBMITTALS

- A For each dampproofing material specified, submit product data in accordance with Conditions of Contract and Division 1 Section "Submittals." Include data substantiating that materials comply with specified requirements.

PART 2: PRODUCTS

2.01 MATERIAL

- A Cold-Applied Asphalt Emulsion Dampproofing: Asphalt-and-water- emulsion coating, compounded to penetrate substrate and build to moisture-resistant coating to all concrete in contact with soil.
 1. Provide heavy fibrated type mastic asbestos-free emulsion; ASTM D1227, Type IV, except containing non-asbestos, inorganic fibrous reinforcement materials.
 2. Provide semi-fibrated type semi-mastic asbestos-free emulsion; ASTM D1227, Type II, except containing non-asbestos fibrous reinforcement and filler materials.
 3. Provide non-fibrated type liquid asbestos-free emulsion; ASTM D1227, Type III.
 4. Manufacturer: Subject to compliance with requirements, provide coal-tar products of one of the following:

- a. Celotex Corporation.
- b. ChemRex, Inc./Sonneborn Building Products Div.
- c. GS Roofing Products Company, Inc.
- d. J & P Petroleum Products, Inc.
- e. Karnak Chemical Corporation.
- f. Koch Materials Company.
- g. Koppers Company, Inc.
- h. Lunday Thagard Company.
- i. Manville Building Materials Corporation.
- j. Tamko Corporation.
- k. Tremco, Inc.

B Water-Base elastic bitumen acrylic emulsion water proof, brush applied, three coats, heat and burning resistant, protection to roofs.

C Miscellaneous Materials: In addition to bituminous dampproofing compounds specified above, provide the following miscellaneous materials as indicated for use in conjunction with dampproofing application:

1. Bituminous Grout: Comply with ASTM D147.

PART 3: EXECUTION

3.01 INSTALLATION

A Preparation: Clean substrate of projections and substances detrimental to work and install cant strips at changes in plane. Fill voids, seal joints and apply bond breakers (if any) as recommended by prime materials manufacturer, with particular attention at construction joints.

B Prime substrate as recommended by prime materials manufacturer.

C Protection of Other Work: Do not allow liquid and mastic compounds to enter and clog drains and conductors. Prevent spillage and migration onto other surfaces of work by masking or otherwise protecting adjoining work.

D Apply bituminous dampproofing to all exterior below-grade surfaces of exterior underground walls in contact with earth or other backfill and where space is enclosed on opposite side.

E Reinforcement: At changes in plane or where otherwise shown as "Reinforced," install lapped course of glass-fiber mat in first coat of dampproofing compound before it thickens.

F Bituminous Cant Strips: Install 100mm by 100mm cant strip of bituminous grout at base of

vertical dampproofing where it meets horizontal surface.

G Extend vertical dampproofing down walls from finished grade line to top of footing, extend over top of footing, and down over the outside face of the footing to the blinding concrete. Extend 300 mm onto intersecting walls and footings but do not extend onto surfaces that will be exposed to view when project is completed.

H Rate of Bitumen Application: Apply dampproofing compound to comply with minimum rate of application to achieve minimum uniform dry film thickness as follows:

1. Brush-applied or spray-applied liquid emulsion: 8 lit/10 m²; minimum 200 micron dry film thickness (DFT).

I Installation of Protection Course: Install protection course of type indicated over completed-and-cured dampproofing treatment. Comply with dampproofing materials manufacturer's recommendations for method of support or attachment of protection materials. Support with spot application of plastic cement where not otherwise indicated.

END OF SECTION

SECTION 08110

STEEL DOORS AND FRAMES

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labour, materials, equipment and incidentals required and deliver the following as shown on the schedules in the Drawings and as specified herein.
1. Steel hollow-metal doors and transom panels.
 2. Pressed-metal door, panel and glass frames.
 3. All fasteners, frame closure pieces, pipe chase, system reinforcing and appurtenances required.
 4. Doors, frames and components shall be galvanized steel where noted and otherwise shall be mild steel.
 5. Set in place, all pressed metal frames which are to be built into walls. Install metal frames which are to be built in concrete openings. Install hollow metal steel doors, louvers and finish hardware furnished under other sections.

1.02 RELATED WORK

- A Field Painting is included in Section 09902.
- B Finish Hardware is included in Section 08710.

1.03 SUBMITTALS

- A Submit to the Engineer as provided in Section 01300, shop drawings of all metal doors, frames, panels and appurtenances.
1. Shop drawings shall show elevations and details of each frame type, schedule of doors and frames, door elevations and details, conditions at openings with various wall thicknesses and materials, location and installation requirements for hardware, thickness of materials, joints and connections and trim.
 2. Where approved to be fabricated in more than one piece, locate and detail field splices and indicate complete instructions for making field splices.
- B Hardware templates shall be furnished to the door manufacturer by the Contractor for correct hardware alignment and reinforcing.
- C Provide samples and certification as follows:
1. Door frame corner with 150 mm long legs showing construction with the galvanized

material specified, welding, touch-up and priming.

2. Door panel corner, 150 mm square, showing door and insulating materials, construction and finishing as specified above.
3. Provide certification as approved that all materials, construction requirements and fire ratings herein specified will be met in the project. Provide similar certification that steel doors and frames are built to labelled construction requirements.

1.04 REFERENCE STANDARDS

A American Society of Testing and Materials (ASTM)

1. ASTM A153 - Specification for Zinc Coatings (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A 525 - Standard Specification for General Requirements for Steel Sheet, Zinc-coated (Galvanized) by the Hot-Dip Process.
3. ASTM A526 - Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.

B Steel Structures Painting Council (SSPC)

1. SSPC - PT2
2. SSPC - PT3
3. SSPC - PT4

C American National Standards Institute (ANSI)

1. A115 - Specification for Preparation of Steel Doors and Frames for Hardware.

D National Fire Protection Association (NFPA)

1. NEPA Standard No. 80 - Fire Doors and Windows.

E Underwriters Laboratories, Inc. (UL)

- F Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

- A Provide custom hollow metal work manufactured by a single firm specializing in the production of this type of work. Hollow metal work shall conform to Hollow Metal Manufacturers Association (Division of National Association of Architectural Metal Manufacturers) standards for commercial hollow metal doors and frames except where more stringent requirements are specified herein.

B Provide custom hollow metal work by one of the following or approved equal:

1. Overly Manufacturing Co.
2. E.H. Froedrich Co.
3. The Philipp Manufacturing Co.
4. Al Muhaideb Manufacturing Co.

1.06 DELIVERY, STORAGE AND HANDLING

A Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact. Doors and panels shall be individually wrapped in corrugated cardboard with wood strips on vertical edges and banded with metal straps. Store materials in nopened packages in a manner to prevent damage from the environment and construction operations. Handle in accordance with manufacturer's instructions.

PART 2: PRODUCTS

2.01 MATERIALS

- A Galvanized steel sheets - Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A526, with ASTM A 525, G90 zinc coating, mill phosphatized.
- B Zinc-rich touch-up primer - 95 percent metallic zinc dust primer in a vehicle compatible with the specified painting system.
- C Supports and anchors - Fabricate of not less than 16 gauge sheet metal. Galvanize after fabrication units complying with ASTM A153. Class B.
- D Inserts, bolts and fasteners - Hot-dip galvanize, complying with ASTM A153, Class C or D as applicable.
- E Rust inhibitive primer - Air drying or baking type as approved compatible with finish paints.

2.02 FABRICATION, GENERAL

- A Fabricate metal units to be rigid, neat in appearance, and free from defects, warp, or buckle. Accurately from metal to required sizes and profiles. Fit and assemble units in the manufacturer's plant including units which are approved to be partially disassembled and field spliced. Weld exposed joints continuously; grind, dress and make smooth, flush and invisible. Metallic filler to conceal manufacturing defects is not acceptable. Clearly identify work that cannot, where approved, be permanently factory-assembled before shipment, to assure proper assembly at the project site.
- B Exposed fasteners - Unless otherwise indicated, provide countersunk flat Phillips or Jackson heads for exposed screws and bolts.

- C Prepare metal units to receive mortised and concealed finish hardware, including cutouts, reinforcing, drilling and tapping in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements for ANSI A 115 series specifications for door and frame preparation for hardware.
- D Reinforce metal units to receive surface -applied hardware. Drilling and tapping for surface-applied finish hardware may be done at project site.
- E Shop Painting - Clean, treat and paint exposed galvanized surfaces of fabricated metal units.
 - 1. Clean steel surfaces of mill scale, rust, oil, grease and other foreign materials and apply approved zinc-rich primer to galvanized surfaces damaged in fabrication.
 - 2. Apply pretreatment to cleaned metal surfaces, using cold phosphate solution (SSPC-PT2), hot phosphate solution (SSPC-PT4) or basic zinc chromate-vinyl butyral solution (SSPC-PT3).
 - 3. Apply one full shop coat of rust inhibitive primer within time limits recommended by pretreatment manufacture. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 2.0 mils.

2.03 DOORS

A General

- 1. Provide flush design doors, 45 mm thick, seamless hollow construction unless otherwise indicated.
- 2. For single-acting swing doors, bevel both vertical edges 3 mm in 50 mm.
- 3. Provide filler of mineral-wool or other approved insulating material solidly packed full door height to fill voids between inner core reinforcing members. No asbestos products will be allowed. Provide a "U" factor of 0.16 maximum for exterior doors.
- 4. Reinforce tubular doors with rigid formed tubular steel where stiles and rails are less than 200 mm wide.
- 5. Provide beads for single and double glazed doors as required.

B Galvanized Steel Doors

- 1. Fabricate doors of two outer, galvanized, stretcher-leveled steel sheets not less than 16 gauge. Construction doors with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges, except around glazed or louvered panel inserts. Provide weep hole openings in the bottom of doors to permit escape of entrapped moisture.
- 2. Reinforce inside of doors with vertical galvanized sheet steel sections not less than 22 gauge. Space vertical reinforcing 150 mm o.c. and extend full door height. Spot-weld at not more than 5-in o.c. to both face sheets.

3. Reinforce tops and bottoms of doors with 16 gauge horizontal steel channels welded continuously to outer sheets. Close top and bottom edges to provide weather seal, as integral part of door construction or by addition of inverted steel channels.
 4. Provide Z or L shape astragals of 14 gauge galvanized steel at double doors. Screw fasten to lead edge of active leaf.
- C Finish hardware reinforcement - Reinforce doors using galvanized steel for required finish hardware, as follows:
1. Hinges - Steel plate 5 mm thick by 38 mm wide by 150 mm longer than hinge, secured by not less than six spot-welds.
 2. Mortise locksets and dead bolts - 14 gauge steel sheet, secured with not less than two spot-welds.
 3. Cylinder locks - 12 gauge steel sheet, secured with not less than two sport-welds.
 4. Flush bolts - 12 gauge steel sheet, secured with not less than two spot-welds.
 5. Surface-applied closers - 12 gauge steel sheet, secured with not less than six spot-welds.
 6. Push plates and pull handles - 16 gauge steel sheet, (except when through bolts are shown or specified), secured with not less than two spot-welds.
 7. Other required comparable reinforcements as submitted and approved.

2.04 FRAMES

- A Provide pressed metal frames for doors, transoms, side-lights, borrowed lights and for other openings where shown, of size and profile as indicated.
- B Fabricate frames of full-welded unit construction, with corners mitered, reinforced, continuously welded full depth and width of frame.
- C Form frames of 14 gauge galvanized steel sheets.
- D Finish hardware reinforcement - Reinforce frames using galvanized steel for required finish hardware, as follows:
1. Hinges and pivots - Steel plate 5 mm thick by 30 mm wide by 150 mm longer than hinge, secured by not less than six spot-welds.
 2. Strike plate clips - Steel plate 5 mm thick by 30 mm wide by 75 mm long.
 3. Surface-applied closers - 12 gauge steel sheet, secured with not less than six spot-welds.

- E Where installed in masonry, leave vertical mullions in frames open at top for grouting.
- F Jam anchors - Furnish jamb anchors as required to secure frames to adjacent construction, formed of not less than 18 gauge galvanized steel.
1. Masonry construction - Adjustable, flat corrugated, or perforated t-shaped to suit frame size, with leg not less than 50 mm wide by 250 mm long. Provide U.L. approved fixed anchors at labelled openings. Furnish at least three anchors per jamb up to 2280 mm height; four anchors up to 2430 mm jamb height; one additional anchor for each 610 mm or fraction thereof over 2430 mm height.
 2. In-place concrete or existing masonry - Anchor frame jambs with minimum 10 mm concealed bolts into expansion shields or inserts 152 mm from top and bottom and 660 mm o.c., unless otherwise shown. Reinforce frames at anchor locations. Apply removable stop to cover anchor bolts unless otherwise indicated.
- G Floor anchors - Provide floor anchors for each jamb and mullion which extends to floor, formed of not less than 14 gauge galvanized steel sheet, as follows:
1. Monolithic concrete slabs - Clip type anchors, with two holes to receive fasteners, welded to bottom of jambs and mullions.
 2. Separate finish concrete slabs - Adjustable type with extension clips, allowing not less than 50 mm height adjustment. Terminate bottom of frames at finish floor surface.
- H Head strut supports - Provide 10 mm by 50 mm vertical steel struts extending from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable bolted anchorage to frame jamb members.
- I Structural reinforcing members - Provide built-in as part of frame assembly where indicated at mullions, transoms, or other locations. Size as required to accommodate superimposed loads and loads from the pressed-metal system itself.
- J Head reinforcing - For frames over 1220 mm wide in masonry wall openings, provide continuous steel channel or angle stiffener, not less than 12 gauge for full width of opening, welded to back of frame at head.
- K Spreader bars - Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.
- L Plaster guards - Provide 26 gauge galvanized steel plaster guards or dust cover boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware installation.

PART 3: EXECUTION

3.01 INSTALLATION

- A Install hollow metal units and accessories in accordance with approved shop drawings, manufacturer's data and as specified herein.
- B Setting masonry anchorage devices - Provide masonry anchorage devices where required for securing hollow metal frames to in-place concrete or existing masonry construction. Set anchorage device opposite each anchor location, in accordance with details on shop drawings and anchorage device manufacturer's instructions. Leave drilled holes rough, not reamed and free from dust and debris.
- C Placing Frames - Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged.
 - 1. In new masonry construction, coordinate frame setting with and prior to the building of masonry walls. Provide the required anchors for building in place.
 - 2. At in-place concrete or existing masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.
 - 3. Place frames at fire-rated openings in accordance with NFPA Standard No. 80.
 - 4. Make field splices in frames as detailed on final approved shop drawings, welded and finished to match factory work.
 - 5. Remove spreader bars only after frames or bucks have been properly set and secured.

3.02 ADJUSTMENT AND TOUCH-UP

- A Leave work in complete and proper operating condition. Remove and replace defective work, including doors or frames which are warped, bowed or otherwise unacceptable.
- B Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

END OF SECTION

SECTION 08710

FINISH HARDWARE

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor and materials required and install all finish hardware as shown on the Drawings and as specified herein.
- B The extent of builders hardware is shown on the drawings, by the provisions of this section and in schedules. Builders hardware is hereby defined to include all items known commercially as builders hardware, as required for swing and sliding doors, except special types of unique and non-matching hardware specified in the same section as the door and door frame.
- C The required types of builders hardware and related items include, but are not necessarily limited to, the following:

- Butts and hinges
- Pivots
- Lock cylinders and keys
- Lock and latch sets
- Bolts
- Push/Pull units
- Splash plates
- Stripping and seals
- Key Control

1.02 QUALITY ASSURANCE

- A Acceptable Designs: Part 2 of this section indicates products which are of acceptable design for primary exposure (lock sets, etc.). Do not change the selection of products, except with Engineer's acceptance.

1.03 SUBMITTALS

- A Manufacturer's Data: Submit manufacturer's product data, including illustrations, for each item of hardware in accordance with specification Section 01300. Include whatever information may be necessary to show compliance with requirements and include instructions for installation and for maintenance of operating parts and exposed finishes.

Wherever needed, furnish templates to fabricators of other work which is to receive finish hardware. Transmit copy of applicable data to the installer.

- B Hardware Schedule: In accordance with specification Section 01300 submit a complete hardware schedule. Hardware schedules are intended for coordination of

the work. Review and acceptance by the Engineer or Employer does not relieve the Contractor of his exclusive responsibility to fulfill the requirements as shown and specified.

- C Meet with the Employer's representative and determine his requirements regarding keying of locks. Submit in accordance with specification Section 01300 a separate key schedule, showing clearly how the Employer's final instructions on keying of locks have been fulfilled.
- D Samples:
 - 1. Prior to submittal of the final hardware schedule and prior to delivery of hardware, submit one sample of each exposed hardware unit, finished as required and tagged with full description for coordination with the schedule. Sample will be reviewed by the Engineer for design, color and texture only. Compliance with other requirements is the exclusive responsibility of the Contractor.
 - 2. Samples will be returned to the Contractor. Units which are acceptable and remain undamaged through submittal, review and field comparison procedures may, after final check of operation, be used in the work, within imitations of keying coordination requirements.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A Packaging of hardware, on a set by set basis, is the responsibility of the Contractor. As material is received from the various manufacturers, sort and repackage in containers marked with the hardware set number. Two or more identical sets may be packaged in the same container.
- B Inventory hardware jointly with representatives of the hardware supplier and the hardware installer until each is satisfied that the count is correct.
- C Acceptable Manufacturers: Part 2 of this section indicates acceptable manufacturers for the primary items of builders hardware. Manufacturer's products which comply with the indicated requirements are acceptable for other items.
- D Supplier: A recognized builders hardware supplier who has been furnishing hardware to similar project, for a period of not less than five years, and who is or has in employment an experienced hardware consultant who is available at reasonable times during the course of the work for project hardware consultation to the Employer, Engineer and Contractor.
- E Departures From Scheduled Designations: Except as otherwise indicated, the use of one manufacturer's numeric designation system in schedules does not imply that another manufacturer's products will not be acceptable, unless they are not acceptable in design, or not equal in size, weight, finish, function or other quality of significance. However, do not change the selection after Engineer's acceptance of supplier's completed hardware schedule.

- F Provide secure lock-up for hardware delivered to the project, but not yet installed. Control the handling and installation of hardware items which are not immediately replaceable, so that the completion of the work will not be delayed by hardware losses, both before and after installation.

1.05 JOB CONDITIONS

- A Coordination: Coordinate hardware with other work. Tag each item or package separately with identification related to the final hardware schedule, and include basic installation instructions in the package. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function. Deliver hardware items, packaged as above indicated, at the proper times to the proper locations (shop or project site) for installation.
- B Templates: Furnish hardware templates to each fabricator of doors, frames and other work to be factory-prepared for the installation of hardware. Upon request, check the shop drawings of such other work to confirm that adequate provisions are made for the proper installation of hardware.

PART 2: PRODUCTS

2.01 MATERIALS AND FABRICATION

- A General:
 - 1. Hand of Door: The Drawings show the direction of swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of the door movement as shown.
 - 2. Base Metals: Produce hardware units of the basic metal and forming method indicated, using the manufacturer's standard metal alloy, composition, temper and hardness. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.
 - 3. Fasteners: Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
 - 4. Furnish screws or through bolts for installation, with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws and bolts to match the hardware finish or, if exposed in surfaces of other work, to match the finish of such other work as closely as possible, including "prepared for paint" in surfaces to receive painted finish. Provide through bolts for closers.
 - 5. Tools for Maintenance: Furnish a complete set of specialized tools as needed

for Employer's continued adjustment, maintenance, and removal and replacement of builders hardware.

2.02 HINGES, BUTTS AND PIVOTS

- A Templates and Screws: Provide only template-produced units.
- B Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - 1. Steel Hinges: Steel pins.
 - 2. Non-ferrous Hinges: Stainless steel pins.
 - 3. Exterior Doors: Non-removable pins.
 - 4. Out-swing Corridor Doors: Non-removable pins.
 - 5. Interior Doors: Non-rising pins.
 - 6. Tips: Flat button and matching plug, finished to match leaves.
- C Provide hinges and pivots which will continuously support weights equal to or exceeding those recommended by the manufacturer for the weight of the door for which they are to be used.
- D Provide anti-friction hinges on doors equipped with closers.
- E Provide ball bearing, extra heavy, butts for doors over 800mm wide.

2.03 LOCK CYLINDERS AND KEYING

- A General: Provide keying as specified herein.
- B Standard System: Except as otherwise indicated, provide new masterkey system for project.
- C Equip locks with manufacturer's 6-pin tumbler cylinder
- D Metals: Construct lock cylinder parts from stainless steel or nickel silver.
- E Comply with the keying Schedule for Great Grand masterkeying and, except as otherwise indicated, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.
- F Key Material: Provide keys of nickel silver only.
- G Key Quantity: Furnish 3 change keys for each lock; 5 master keys for each master system
- H Deliver keys to Employer's representative.

- J Provide a key control system including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of the number of locks required for the project.

2.04 LOCKS, LATCHES AND BOLTS

- A Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set.
 - 1. Provide dust-proof strikes for foot bolts, except where special threshold construction provides non-recessed strike for bolt.
 - 2. Provide roller type strikes where recommended by manufacturer of the latch and lock units.
- B Lock Throw: Provide 16mm minimum throw of latch and deadbolt used on pairs of doors. Provide 12.5mm minimum throw on other latch and deadlock bolts. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.
- C Flush Bolt Heads: Minimum of 12.5mm diameter rods of stainless steel, with minimum 150mm long rod.

2.05 PUSH/PULL UNITS

- A Exposed Fasteners: Provide manufacturer's standard exposed fasteners for installation; through-bolted for matched pairs, but not for single units.

2.07 SPLASH PLATES AND MIDRAIL PLATES

Provide splash plates on both sides of all door leaves. Furnish stainless steel plates, not less than 1.6mm thick, 200mm high and 40mm less than the door leaf width. Finish to match the rest of door hardware set.

2.06 STRIPPING AND SEALS

- A Continuity of Stripping: Except as otherwise indicated, it is required that the stripping at each opening be continuous and without unnecessary interruptions at door corners and hardware.
- B Replaceable Seal Strips: It is required that the resilient or flexible seal strip of every unit be easily replaceable and readily available from stocks maintained by the manufacturer.
- C Weather-Stripping: Provide types of weather-stripping indicated, properly prepared for attachment to supporting units.

2.07 ACCEPTABLE DESIGNS AND MANUFACTURERS

- A Except as otherwise specifically indicated “SARGENT” and “ALL GOOD” products shall be used as a standard reference to acceptable design and manufacturer. Alternatively, Corbin or Russwin products may be used.
- B Where no manufacturer has been specified, provide best quality, heavy duty products suitable for the intended use.
- C Refer to Div 5 for splash plates fabrication.

2.08 HARDWARE SCHEDULE SET SUBMITTAL FORM

- A. Example of Hardware Set form to be used for Hardware Schedule submittal:

Hardware Set No. HW-Set(1):

HW Set (1)

3 pair Hinges steel, matt finish	Ball bearing, stainless (100 x 100 x 3mm).
1 No. Lock	Morticed master keyed.
1 set Handles (165x165mm)	Levered matt stainless steel
1 pair Stop	Floor mounted.
1 pair Flush Bolts	Sunk slide (19x152mm)
1 No. Floor Socket	Dust excluding socket 10mm dia bolt.

1 pair Splash Plate 1.6mm thick 200mm high

2.09 HARDWARE SETS

Hardware Sets should be as indicated in doors schedules, description in each hardware set establishes quality, performance, function and components.

HW Set (1)

1-1/2 pair Hinges matt finish (100 x 100 x 3mm).	Ball bearing, stainless steel,
1 No. Lock	Morticed master keyed.
1 Set Handles (165x165mm)	Levered matt stainless steel
1 No. Stop	Floor mounted.
1 pair Splash Plate	Stainless steel; 200m highx40mm less than door leaf width

HW Set (2)

3pair	Hinges	Ball bearing, stainless steel, matt finish (100x100x3mm)
1	No. Lock	Morticed master keyed
1	set Handles	Levered Matt stainless steel
2	pair Splash Plates	Stainless steel; 200mm highx40mm less than door leaf width.
2	No Door stop,	floor mounted

HW Set (3)

1	pair Door door handles	Fixed (grab handle) stainless steel matt
1	No. Sliding Mechanism	Top mounted with floor guide and stop
1	pair Splash plates	Stainless steel 200 mm high full width of door indicator and emergency release facility (165x165mm)

PART 3: EXECUTION

3.01 HARDWARE MOUNTING HEIGHTS

A Mount hardware units at the locations recommended by the hardware and door and frame manufacturers for each door or door opening, except as otherwise specifically indicated, or required to comply with governing regulations, and except as otherwise directed by the Engineer.

3.02 PREPARATION

A Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protection with finishing work. Do not install surface-mounted items until finishes have been completed on the substrate.

B Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

C Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

D For exterior doors, cut and fit threshold and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items.

- E Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.
- F Exactly align top and bottom pivots and top, bottom and intermediate pivots.
- G At exterior doors and elsewhere as indicated on approved shop drawings, set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture from every source. Do not plug drainage holes or block weeps. Remove excess sealant.

3.04 ADJUST AND CLEAN

- A Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.
- B Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- C Instruct Employer's Personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.
- D Continued Maintenance Service: Approximately six months after the acceptance of hardware in each area, the Installer, accompanied by the representative of the latch and lock manufacturer, shall return to the project and re-adjust any required item of hardware to restore proper function of doors and hardware. Consult with and instruct Employer's personnel in recommended additions to the maintenance procedures. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units.

END OF SECTION

SECTION 08800

GLAZING

PART 1: GENERAL

1.01 SCOPE OF WORK

- A Furnish all labor, materials, equipment and incidentals required and install all glass and glazing as shown and as specified herein.

1.02 SUBMITTALS

- A Submit to the Engineer two representative samples of each type glazing material specified below. Provide samples of glass in 300 mm square minimum size.

Resubmit any or all as required until approved.

- B Submit to the Engineer, as provided in Section 01300, full size shop drawings showing step-by-step glass setting and sealing procedures. Submit certification that wired glass is UL tested and approved.

1.03 REFERENCE STANDARDS

- A American Society for Testing and Materials (ASTM)

1. ASTM E774 - Specification for Sealed Insulating Glass Units.

- B Underwriters Laboratories Inc. (UL)

- C National Fire Protection Association (NFPA)

- D Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 DELIVERY, STORAGE AND HANDLING

- A All materials for the work of this Section shall be delivered, stored and handled so as to preclude damage of any nature. All glass shall be delivered and stored in its original container, plainly marked with identification of material and maker. Materials in broken containers or in packages showing water marks or other evidence of damage shall not be used and shall be removed from the site.

PART 2: PRODUCTS

2.01 MATERIALS

- A Each piece of glass shall bear the manufacturer's label showing the strength, grade, thickness, type and quality of the glass and all labels shall remain in place until the glass has been set and inspected by the Engineer except that safety and insulating glass shall have permanently

etched labels. When glass is not cut to size by the manufacturer and is furnished from local stock, the glass and glazing subcontractor shall submit an affidavit stating the strength, grade, thickness, type, quality and manufacturer of the glass furnished.

- B All non-labelled door glass and window glass shall be clear (except as specified below) glass, 6 mm thick Herculite by PPG Industries, equal by L.O.F.; A.F.G. or equal.
- C All labelled door glass and glass elsewhere as noted shall be 6 mm thick clear polished diamond welded wired glass, UL listed.
- D Glazing compound shall be 999-A Glazing Silicone by Dow, equal by General Electric or equal.
- E Glazing tape for use with the glazing compound shall be Tremco No. 440; Pecora Extru-Seal Butyl Rubber Tape or Dap Inc. Butyl Rubber Sealing Tape or equal. Tape shall be compatible with the glazing compound.
- F Setting blocks, 85 plus or minus 5 durometer and spacer blocks, 50 durometer, shall be closed cell neoprene.
- G Glazing strips for hollow metal door and bead glazing, shall be adhesive faced closed cell PVC foam strip, 3 mm thick, 32 durometer hardness.
- H Glazing compound for labelled construction glazing shall meet NFPA requirements for a hard setting glazing compound with 90 percent inert and non-flammable components as approved.

PART 3: EXECUTION

3.01 INSTALLATION

A General

1. All glazing work shall be performed in accordance with the standards of the Flat Glass Marketing Association's Glazing Manual, latest revision, unless otherwise noted or specified and shall also conform to the approved shop drawings and the manufacturer's glazing instructions.
2. All frame elements shall have been painted where required and shall be thoroughly cleaned before glazing commences.

B Exterior Glazing - Non-gasket system - Inside glazed.

1. Set tape 3 mm down from top of fixed bead.
2. Run a bead of approved gun-grade sealant from base of tape to bottom of glazing pocket leaving weep holes, where provided, free of sealant.
3. Place setting blocks, insert glass and press against tape and sealant until continuous perimeter contact is made.

4. Run a heel bead of approved sealant along exposed edge of glass.
5. Apply glazing bead.
6. Install spacer between glazing bead and glass.
7. Run a continuous finish bead of sealant to fill voids above spacers on interior side and to fill void above tape on exterior side.

C Exterior Glazing - Gasket System

1. Glaze per approved shop drawings using gaskets and appurtenances furnished with the system. Provide setting blocks as required.

D Door and Interior Glazing - Non-Labelled Openings

1. Install continuous glazing strip against rabbet.
2. Set glass in place on setting blocks and install another continuous glazing strip around perimeter of glass.
3. Install glazing beads, setting against glazing strips, firmly, in order to place a small amount of pressure against the strips.

E Labelled Opening Glazing

1. Bed glazing rabbet in the approved hard-setting compound.
2. Set glass using setting blocks.
3. Face glass in the same compound and set beads.
4. Tool compound flush and full between glass and metal surrounds, adding compound as required.

3.02 PROTECTION AND CLEANING

- A Clean and remove all labels from all glass when directed and clean glazing compound from frames around glass installed under this Section upon completion of the work. All defective or broken glass and glass broken because of faulty setting shall be replaced under this Section.
- B All glass shall be protected under this Section from accidental damage with tapes or streamers attached to the sash or frame. No tape or streamer shall contact the glass.

END OF SECTION